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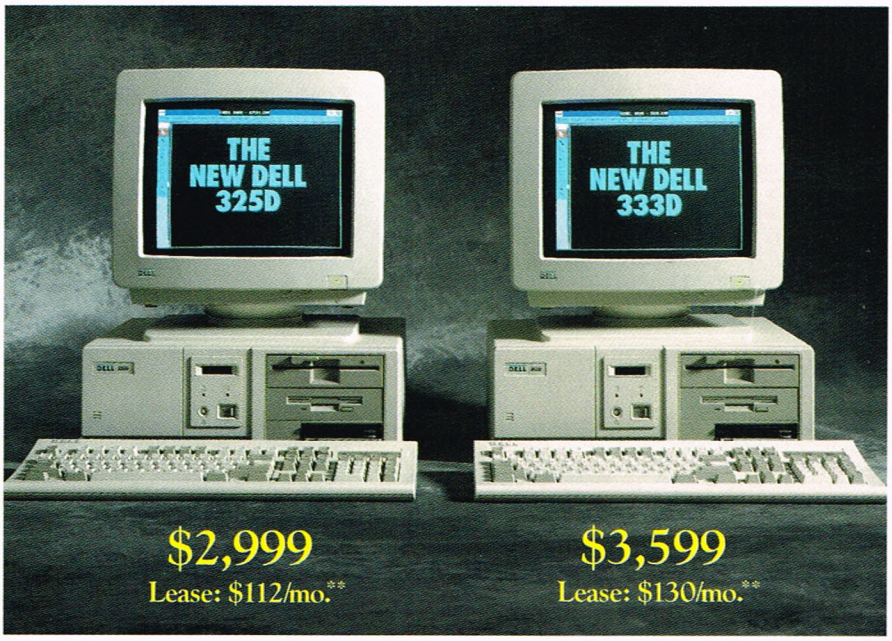
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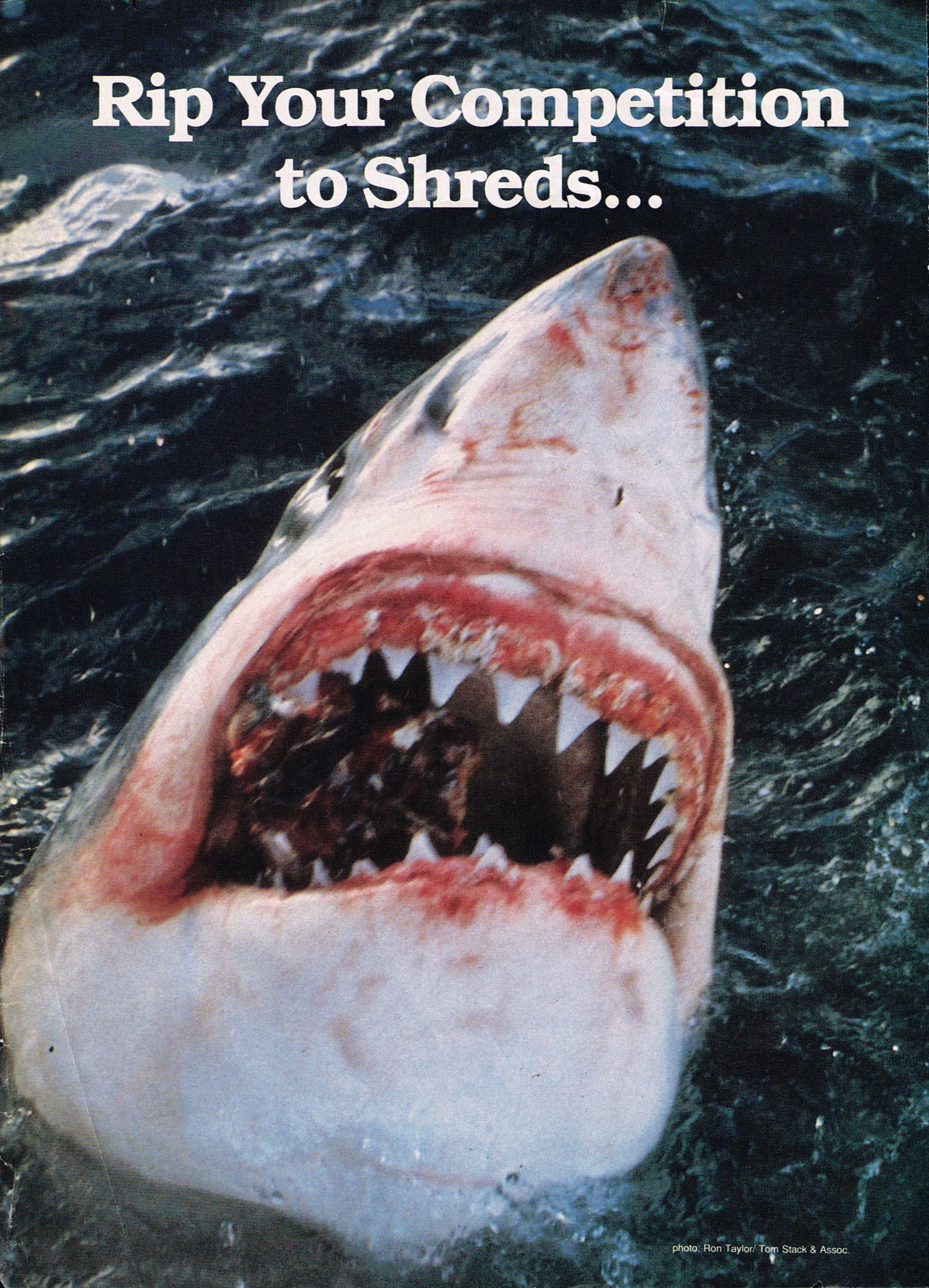


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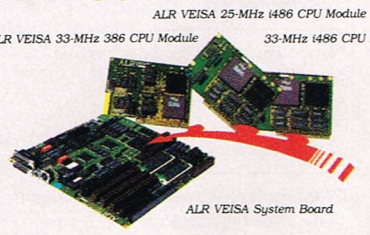
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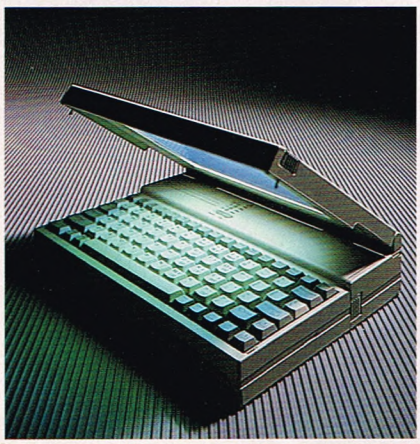
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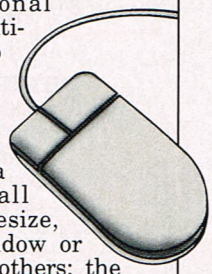
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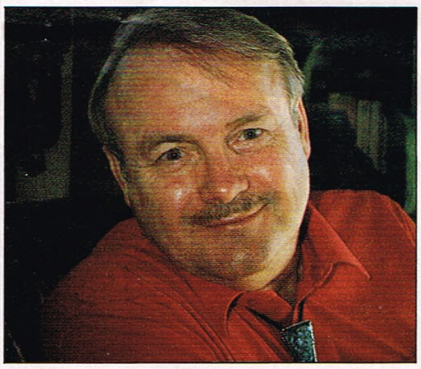
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S P O T L I G H T



JERRY POURNELLE: 10 YEARS AND COUNTING

There's a lot more to BYTE's senior contributing editor than just his column

He's been called "the world's most popular computer columnist," and with justification. Jerry Pournelle's columns appear in dozens of countries, both in English and in a variety of other languages. He has fans from Michigan to Moscow, from Kokomo to Kyoto.

As a BYTE reader, you probably already know why: For the last 10 years, Jerry's blend of hands-on, first-person experience with every conceivable kind of hardware and software has provided some of the most entertaining and informative pages in BYTE each month.

But there's a lot more to Jerry than his column. You've probably either read or heard of a number of Jerry's best-selling books (written alone or in collaboration with Larry Niven and others), including *The Legacy of Heorot*, *Footfall*, *Oath of Fealty*, *Lucifer's Hammer*, *The Mote in God's Eye*, and many others. Jerry's list of published works would more than fill the space we have here; over 20 books are still in print.

A native of Shreveport, Louisiana, Jerry earned a B.S. in psychology and mathematics, an M.S. in experimental statistics and systems engineering, and two Ph.Ds: one in psychology, the other in political science.

With that broad a background, it's easier to understand how Jerry has ended up employed by agencies as varied as the City of Los Angeles, Pepperdine University, the U.S. Air Force, North American Rockwell Corp., and Boeing Aerospace Corp. What's harder to understand is how he did it while still developing a world-class writing career.

But wait, there's more: Jerry's also made time to chair the Citizen's Advisory Council on National Space Policy, and to be a consultant to the trustees of the California State Universities; a member of the Board of Visitors, Department of Mathematics, University of Texas; and a member of the advisory board, Lowell Observatory, Flagstaff, Arizona.

Jerry was one of the first authors to use a computer for writing both fiction and nonfiction (see "Writing with a Microcomputer," *onComputing*, Summer 1979). His work began appearing in BYTE just one year later.

We're pleased to be able to bring you a writer of Jerry's caliber each month. If you're already a fan, watch for some interesting, positive changes in the column over the next few months, as we usher in Jerry's second decade with BYTE. If you're not reading Jerry, do yourself a favor: Check out this month's column. ■

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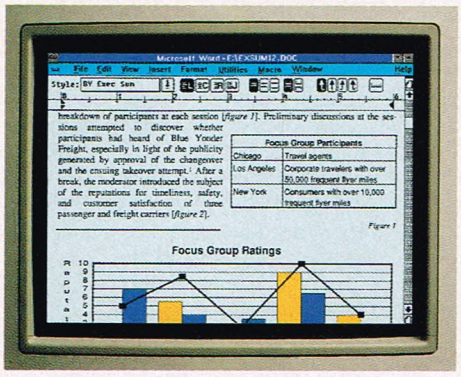
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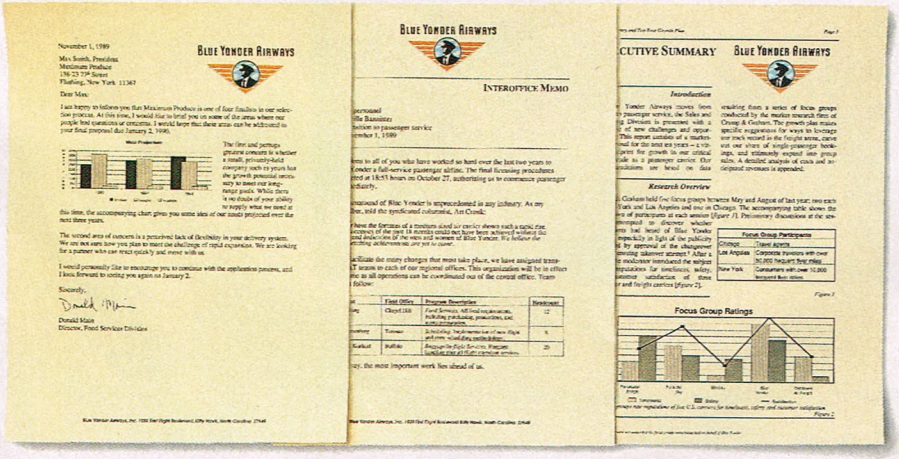
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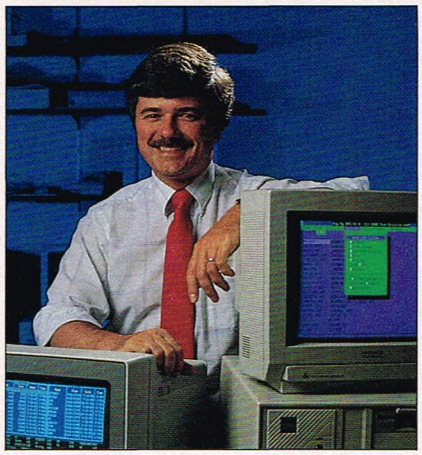
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LAPTOP TROUBLES AND TRIUMPHS

Business practice—not technology—is now the impediment

I love laptops. Given enough funds, I'd go for laptops the way Imelda Marcos went for shoes.

The list of portables I've owned or used stretches back to the days when (figuratively speaking) computers were made out of animal bones and plant fiber. In fact, before there were portables, I routinely went on the road with an Atari 800, two external floppy disk drives, an acoustic coupler, a dictionary-size "interface box," and a shopping bag full of cables and brick-size power supplies. I had more than one chat with hotel security when maids panicked at the sight of the wires and boxes covering a room's spare bed.

A Winner

Things got simpler with the first true portables and then, some years later, with the first laptop—the Tandy Model 100. I still have my original M100, and I use it on trips where I am unwilling to risk loss or damage to more recent equipment, or where power supplies are a problem.

Other Contenders

I've had other memorable machines, too. The almost-compatible DataVue, for example, stands out because it kept me up and running during the power outages of hurricane Gloria some years back. But the DataVue's idiosyncrasies meant that I couldn't telecommunicate the work I'd done, thus negating one of the prime reasons for having a laptop.

Also-Rans

Way back when, I had a brief flirtation with the almost-legible DG One, but I decided that I really needed to be able to see what I was working on. Very recently, I tried lugging a 12-pound VGA laptop, but decided my arms were already long enough. Other machines had great screens but nonstandard microfloppy disks, or powerful CPUs but pricey ROM-card software.

Still other laptops seemed great in office settings, but they turned out to be useless on planes unless the person in front of me sat perfectly upright—if he or she tilted the seat back, it would fold the computer's screen shut. Palmtops were either too tiny to type on or too limited in use to fully replace a "real" computer, even though they may excel at replacing paper-based pocket diaries, agenda booklets, and to-do lists. (And "excel" they do: A pocket computer such as the Sharp Wizard can be a perfect accompaniment to a full-blown portable.)

No More Compromises

This theme—having to make substantial compromises when computing outside a traditional office setting—has been constant. Until now.

Starting late last year, laptops shed their last real technological hurdles. Smaller than ever, lighter than ever, faster than ever, today's laptops (yes, I'm including the subclasses of notebook and palmtop computers) now truly can offer full-function portable computing with very few compromises. (Check out the cover story on the Compaq 386s/20 and this month's review of the Texas Instruments TravelMate.)

But there's still one persistent catch. If the new crop of laptops is making you think of taking the plunge, it's something you should be aware of.

It's human behavior—specifically, office decorum and the etiquette of business meetings. Take notes on a piece of paper, for example, and no one cares; take notes on a laptop, and the novelty of it can cause a commotion; the mere act of computerized note taking can pull a meeting off track—your use of a portable computer actually decreases productivity instead of increasing it.

If you are making a presentation, there is a similar problem: Speak from notes, and your audience will listen to your message—but refer to notes on a laptop screen, and for a few minutes, at least some in your audience will pay more attention to how you're delivering your message than to the message itself. That's a sure way to torpedo a presentation.

While those can be serious problems, there are smaller snags, too: Working on a plane, if you write a memo in longhand, your concentration will be undisturbed. Try typing on a laptop, and you can expect friendly interruptions ("Hey! What is that?") from your seatmate and from people walking by in the aisle.

Problems Become Moot

Of course, handwritten notes always can be rekeyed later. A speech given from note cards may well be better than one delivered from a laptop, because you'll be able to walk around instead of being tied to a podium. And answering the questions of curious airline seatmates helps spread the word about computers and introduces a new set of users to these amazing machines.

As more laptops move out into the world, the curiosity factor will diminish, and computers will become as accepted in boardrooms, on podiums, and in public transport as they now are on desktops. But for now, the relative novelty means there will be some inconvenience, and you may not immediately get all the time and productivity gains you hope for.

Personally, I think it's a small price to pay for the huge gains that are to be had. I can't imagine traveling without a laptop—and once you've tried one of today's slick new machines, neither will you.

—Fred Langa
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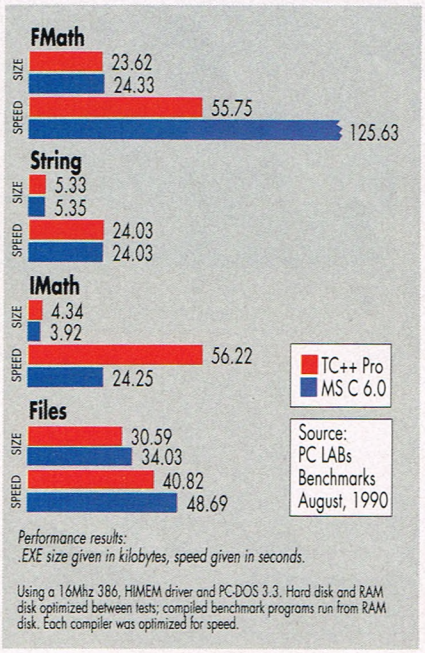
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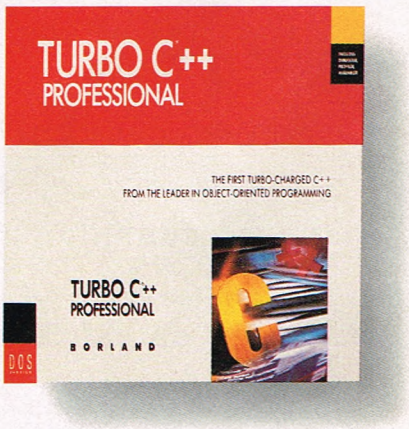
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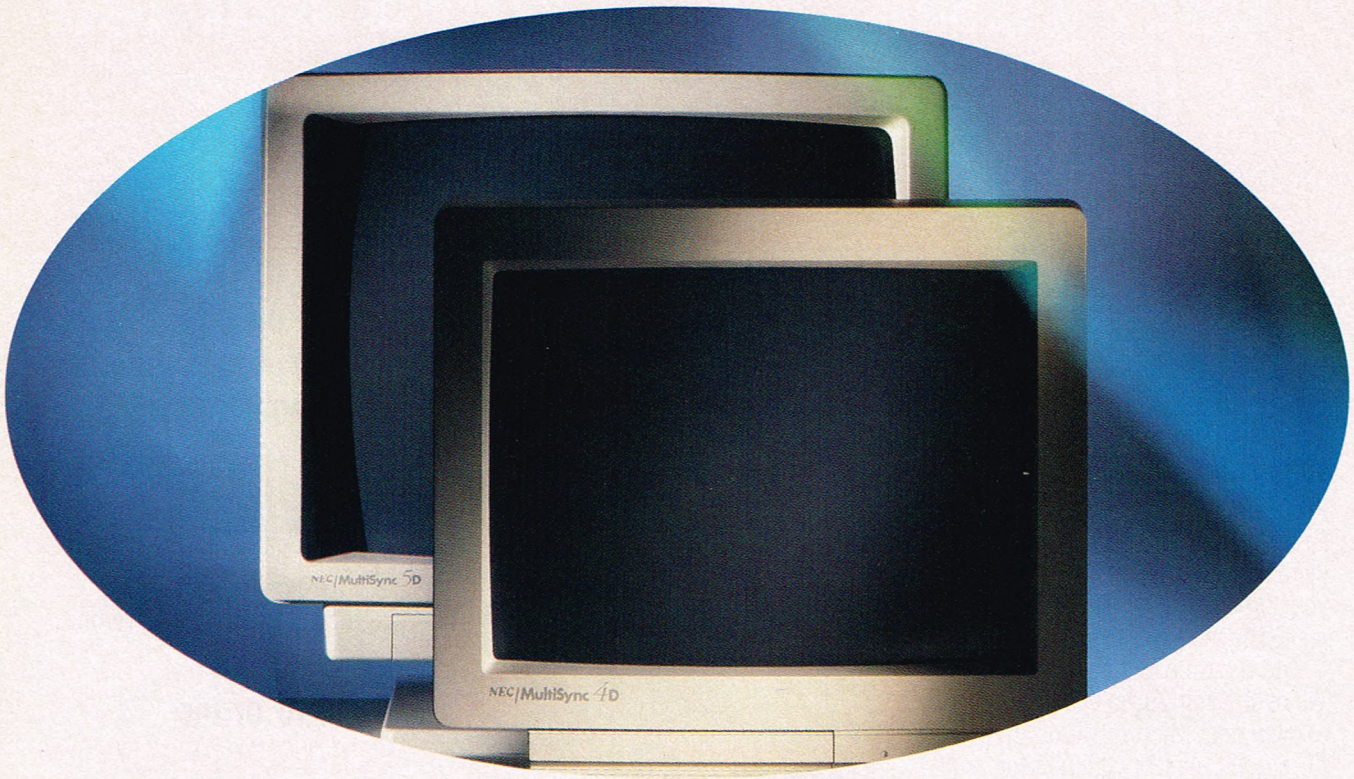
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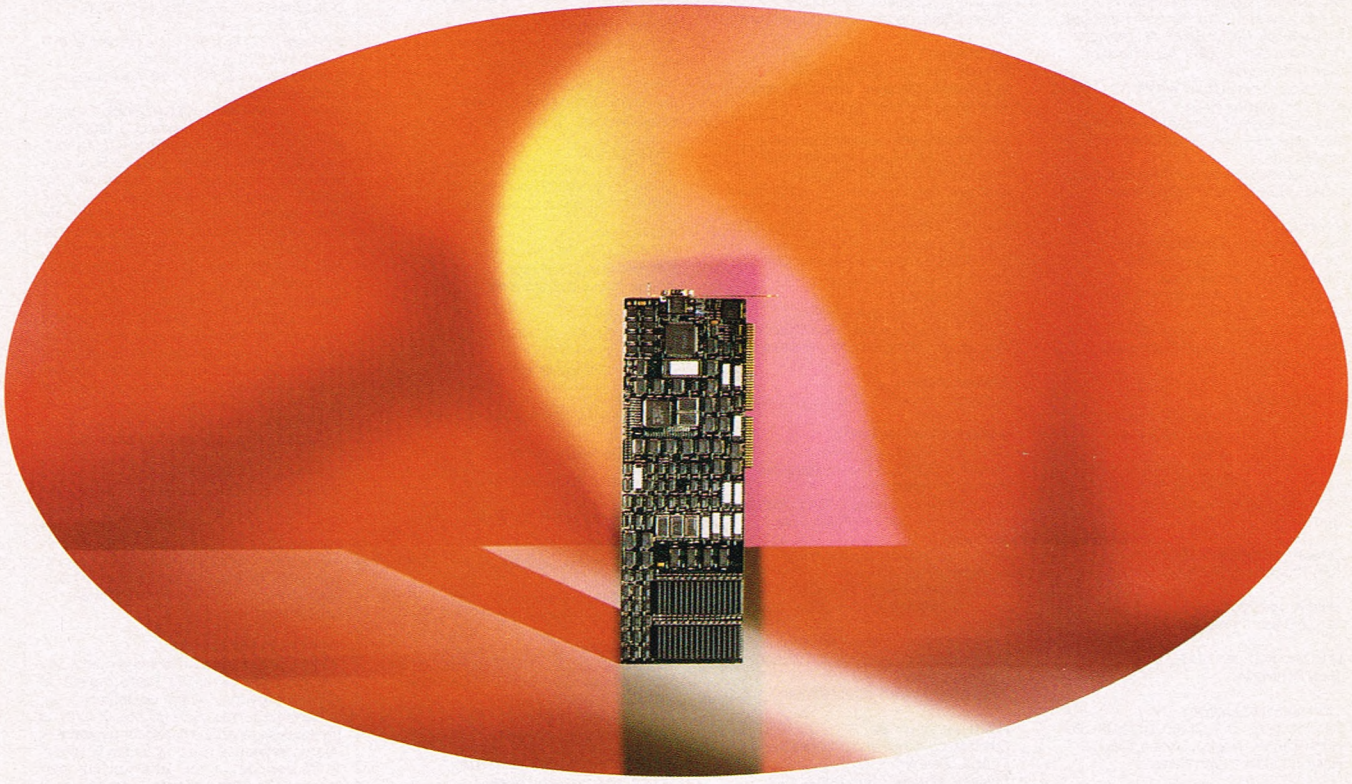
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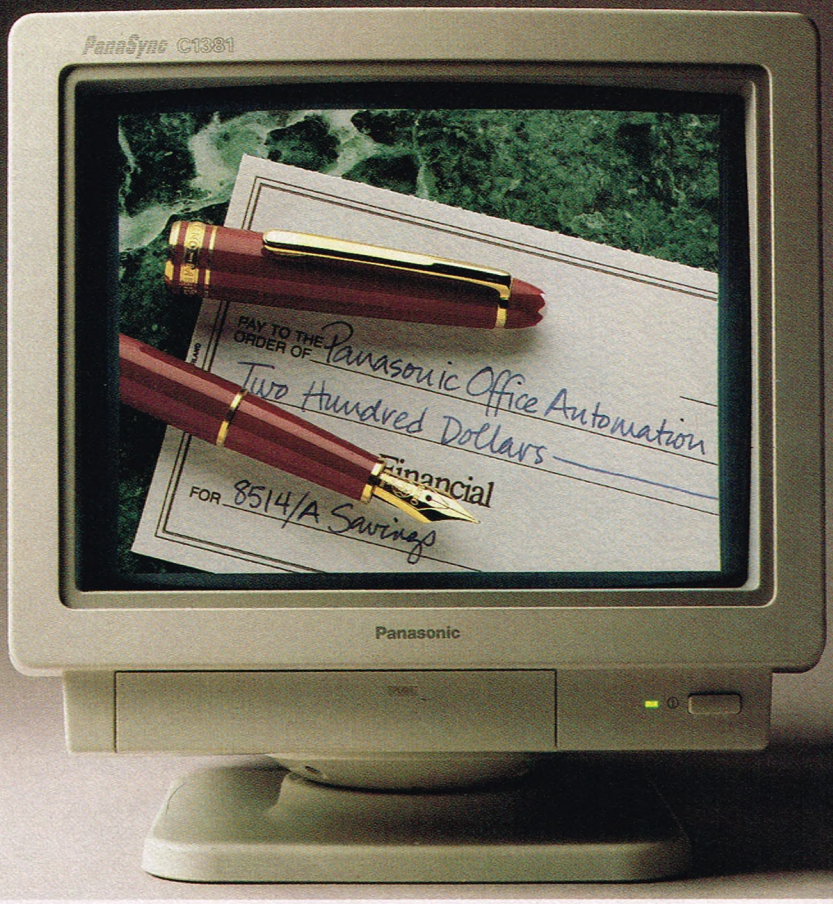
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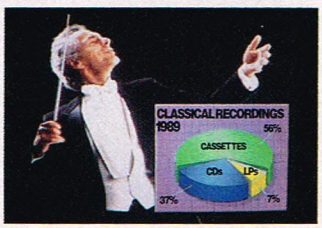


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MICROBYTES

Research news and industry developments shaping the world of desktop computing
Edited by D. Barker

Minimalist Architecture Promises Speed, Chips That Can Mimic Others

A new minimalist microprocessor architecture being developed by Teraplex (Champaign, IL) could lead to systems that not only are faster but can emulate other processor architectures as well. Teraplex's Minimum Instruction Set Computer design uses, as its name implies, the minimum number of instructions possible to build a basic computer architecture. MISC uses long instruction words to fetch more than one operand at a time, and, according to Teraplex officials, it processes data significantly faster than most current desktop computers.

Perhaps an even greater benefit than speed is the MISC chip's ability to imitate other processors by mimicking their instructions with combinations of its own. Because of its high speed, the processor can do this quickly enough to attain very good performance, the designers say. According to Teraplex staffers, they've built systems that can directly execute MS-DOS programs at about 4½ times the speed of a 386-based machine running at 33 MHz.

The instructions used in the MISC system are as basic as possible (e.g., add, multiply, logic shift, escape, and trap). MISC handles instructions that are common on current microprocessors, such as move, by reading a data operand, shifting it by 0, and storing it to the instruction-fetch register. The design also uses a novel approach to floating-point operations: It fetches the numbers, unpacks them into exponent and mantissa, aligns them, passes them through the integer unit, and then realigns and repacks them. Teraplex president Philip McKinney says that this



Put away those 3-D glasses. Texas Instruments has prototyped a laser-based display system for projecting three-dimensional images that can be viewed from any angle. As in real life, the visual perspective of the image changes with the viewing angle. Don Williams, a development engineer at TI's Computer Systems Laboratory, is shown here with the OmniView display, described in the company's patent application as "a real-time, auto-stereoscopic, multiplanar 3-D display system." The display surface is a translucent double-helix disk that's mounted on a rotating shaft. As the disk spins (at 600 rpm), a low-power laser beam passes over it. This beam scans the disk in two dimensions, but, as TI explains it, the eye of the beholder "fuses the discrete points of light painted on the disk" into a 3-D image. The spinning disk can be adjusted to change the size and shape of the display space, either short and wide or tall and thin. Resolution of the laser scanning system is about 750 by 750 pixels. The prototype as currently configured can display full-color images generated with a Sun workstation. TI is seeking partners to develop applications that use the new display technology.

NANOBYTES

This won't be the year for the debut of the certified **50-MHz i486**, as it turns out. **Intel** officials have conceded that the top-speed model of the i486 processor won't be ready until next year. The original target date for the i486/50 was "by the end of 1990." An Intel spokesperson said it now looks like "sometime in 1991." That means announcements of 50-MHz i486 machines should begin any day now.

So while Intel keeps working on the 50-MHz i486, a young California company is chilling out. **Velox Computer** (Santa Clara, CA) claims that it can speed up an i486 just **by refrigerating it**. Velox says its Ice Cap module allows i486s to run 50 percent faster than their rated speeds. A 33-MHz i486 can run reliably at 50 MHz, according to Velox president Mel Snyder. The Ice Cap is a refrigeration module, about 3 inches tall, that fits on top of the processor in a conventional microcomputer and cools it to 0°C. It uses a solid-state thermonic element to combat the effects of heat. Active cooling has been used in mainframes for years, but it's rare in microprocessor applications. So far, Snyder says, his company has sold modules to about 40 firms, including Digital Equipment and Everex. **Everex** isn't planning any products that use the cooling tower, but a spokesperson said it's playing with it "to see what 50 MHz does."

The techno-legal morass of **cloning Intel's 386** CPU has bewitched and bewildered some chip makers. But **Integrated Information Technology** (Santa Clara, CA), which already makes its own versions of Intel's math coprocessors, confirms that it is working on a replicant of Intel's top-of-the-line CPUs. "We do have an R&D program to do a 386/486-compatible product," IIT president Chi-Shin Wang told BYTE. It will be a stand-alone CPU that's code-compatible with Intel's, Wang said. Although Wang would not say when that chip will be ready, sources say that it's likely to appear sometime in 1991. As for potential legal problems, Wang said, "In our design, we can get around [Intel's] patents."

technique on the Teraplex 32-bit CMOS design is about as fast as on a MIPS R3000 RISC processor with an FPU.

One advantage to using such basic instructions is that they can be combined easily to form more complex instructions. As a result, the MISC design can emulate other processors. Teraplex officials say they have checked this with a system running MS-DOS programs and have test systems that can run MIPS and SPARC programs. Teraplex is also investigating running Motorola 68000 code.

One of the big advantages of the MISC design is that it doesn't require instruction decoding. Unencoded instruction words directly control the hardware of the chip. The current 32-bit design from Teraplex uses a long instruction word (LIW) technique that fetches 128 bits at a time. The first 64 bits tell the control unit and universal functional unit what to do with the other 64 bits, which are two operands. The benefits of this technique include the elimination of microcode and decoding circuits, as well as the ability to process larger amounts of data more quickly. The current design is capable of operating at about the equivalent of 60 VAX MIPS, according to McKinney.

The MISC approach minimizes the use of clock cycles, which helps to eliminate waiting periods required to make sure that all signals are ready before issuing a clock. The control and functional units that handle processing are designed to filter instructions through without rigidly timing them. McKinney describes this design as a "big Pachinko machine," after the Japanese arcade machines that filter and bounce hundreds of ball bearings through metal pins.

Teraplex programs its chip using compilers and a language called Teraplex Intermediate Language Interface. This is a high-level assembly-like language for an imaginary serial processor. It is expanded by the TILI compiler into direct machine instructions. Higher-level languages like C are first compiled into TILI for execution.

Teraplex plans to begin prototype production of chips by the end of the year and hopes to have commercial workstations and desktop computers based on the chip in the fourth quarter of 1991. Company officials say they're dealing with several third parties to design computer systems around MISC.

Teraplex is not the only company involved in research in this area. There are a few VLIW SPARC systems in the works, and British computing pioneer Clive Sinclair is rumored to have developed a similar processor with a 96-bit instruction word, a design that sources say can emulate existing microprocessors.

Some experts have predicted that architectures using long (and very long) instruction words might supersede RISC designs. By combining this technique with a minimal instruction set, Teraplex is attempting to bring about two design revolutions: raising speed limits, and developing processors that can imitate other processors. The latter goal of processors that can share binary code could herald true interoperability among computers of different designs.

— Owen Linderholm

Montana Researcher Claims Optical Processor

A researcher at the Rocky Mountain Research Center (Missoula, MT) says he has developed the first working optical logic device, capable of performing the Boolean operations that are basic to the electronic transistor. According to John Hait, he has designed a hologram—a photographic recording of a pattern of light beams—that can accept two beams of light as an input signal and return a single light beam as an output. This forms the basis for an inverter or amplifier that can perform exclusive-OR and OR operations, among others.

Hait told BYTE that "a patent search has not turned up" any comparable devices. Although some researchers have written off the possibility of performing logic operations entirely with optics, Hait claims that his invention forms the basic building block for designing purely optical computers. Hait's "optical transistor" performs the logic functions optically, thereby eliminating the need for expensive electronic logic devices such as gallium arsenide substrates, which are nevertheless slower than the equivalent optical device. Hait says his optical transistor could form the basis for optical RAM systems, registers, multiplexers and demultiplexers, and other standard computer components.

Hait says he demonstrated his logic hologram in a laboratory at Montana State University in Bozeman. According to a letter from an MSU physics

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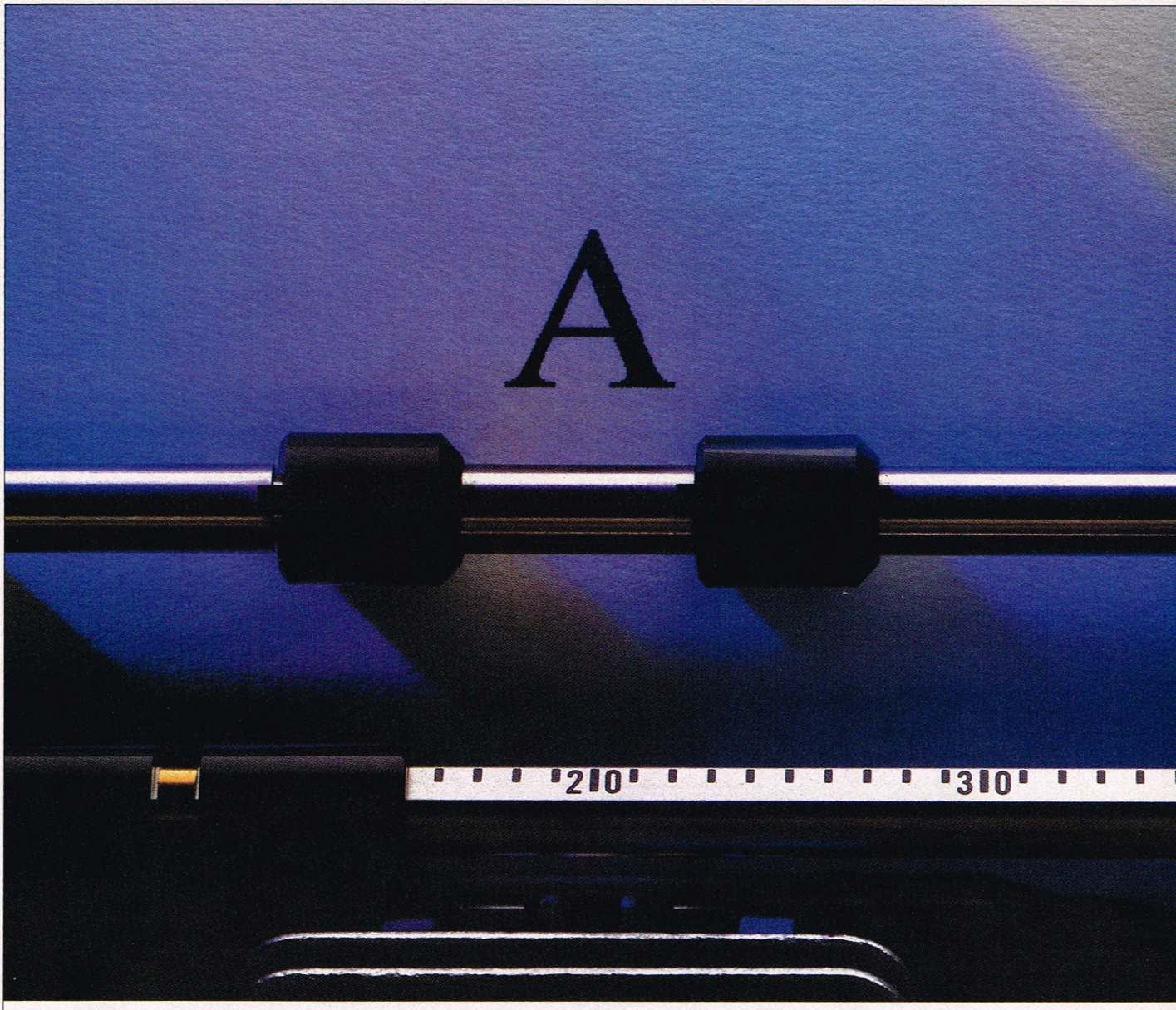
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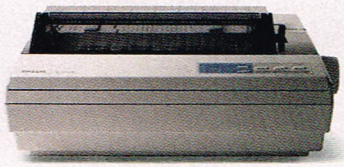
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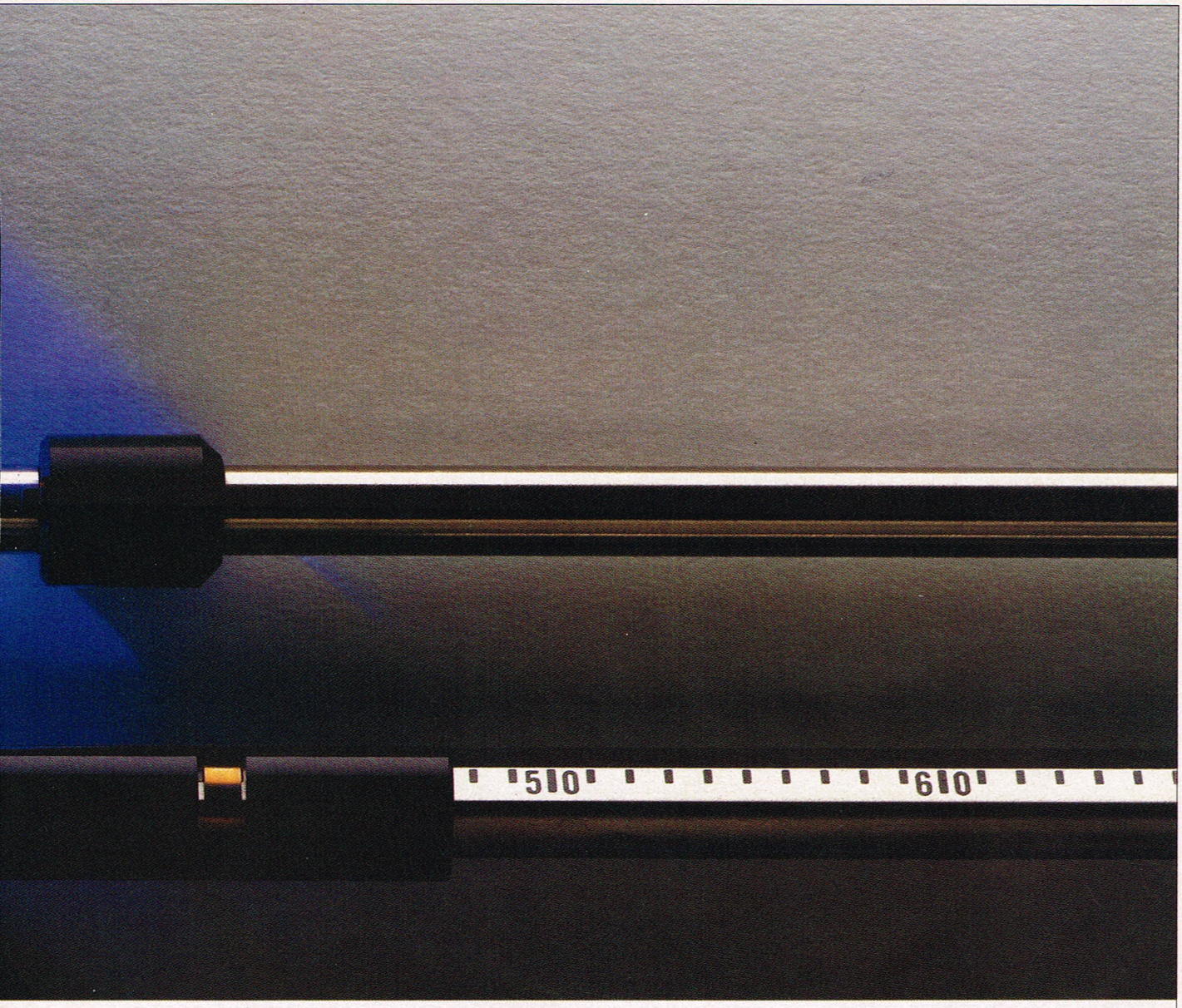


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NANOBYTES

Dell Computer (Austin, TX) has developed a new **disk drive controller card** that's aimed squarely at a similar device announced by Compaq last November at its SystemPro introduction. The Dell Drive Array card features the Intel i960 32-bit RISC chip, a 256K-byte static RAM cache, and connectors for 10 Intelligent Drive Electronics hard disk drives. The card can read and write simultaneously from five disk drives, a company executive said. Dell officials claim that using the controller with four disk drives will yield a system with not only four times the storage capacity but approximately three times the performance. The company is still working on the code for the i960 chip, trying to bring the controller up to this level of performance. When we spoke with them, Dell officials hadn't decided on a price yet for the Drive Array, but they estimated that it could be somewhere around $1200.

Mac upgrade or Mac clone? **Texas MacExpress** (Austin, TX) has designed an "upgrade" for owners of the Mac Plus, SE, and Mac 512KE that the company claims will give them the performance of a Mac IIci for only $2299—about half the cost of the genuine Apple product. The System 30 comes in a box that looks like an IBM-type PC. "The Apple ROMs that are used in the product have been bought by the customers, who disable their old machines when they are taken out," explained Kevin Cochran, president of Texas MacExpress, a subsidiary of Cork Computers. The system is supposed to ship this month, Cochran said. "We've had a team of programmers working for the last six months in-house to produce our own **proprietary operating system that bypasses Color QuickDraw**. It's copyrighted software. That's how a Mac Plus user with ROMs that don't have Color QuickDraw in them can upgrade to color," Cochran told BYTE. The System 30 has three NuBus slots, runs a 68030 at 25 MHz, and has a built-in paged memory management unit and 8-bit video, along with a 1.44-MB FDHD floppy disk drive that uses the Apple File Exchange utility.

professor, Hait demonstrated "several optical digital devices," including "exclusive-OR, OR, amplification, and inverter."

According to Hait, his hologram can be manufactured "synthetically" using software for designing holograms. Hait is looking for a major research lab or company to license his technology and to interface the necessary design software to existing hologram programs. Major improvements in hologram design software are needed to make his invention a viable product, he concedes.

Optical computing devices have made great progress in storage and connection applications (e.g., fiber-optic connections and optical disk drives), but they have proved to be inaccurate when used for computation. Therefore, most research in optics has been devoted to the development of hybrid "electro-optical" computers, which use optics for storage and data transfer and employ electronic semiconductors for performing logic operations. Researchers at AT&T's Bell Labs, British Aerospace, Fujitsu, and other R&D centers have focused on linking optics to high-speed gallium arsenide logic devices.

— Nick Baran

IBM, Metaphor to Build Platform for Portability

Moving application programs to different operating systems, and getting them all to work together, is one of the biggest challenges facing software developers today. Now IBM and Metaphor say they're going to try to make it easier. The two companies have formed a joint venture, called Patriot Partners (Mountain View, CA), to create a new applications software environment that they hope will offer an object-oriented development system for building easily portable programs.

The environment will be independent of current operating systems in that it will ride above the operating-system kernel, but the resultant applications will be able to run on OS/2 and Unix machines, the companies said. An application written for a particular processor architecture will run on that processor, without being modified, regardless of operating system; for other processors, applications will only have to be recompiled, a Metaphor official said. Initial hardware targets are 386-based machines running OS/2 or Unix and IBM's RS/6000 running AIX. Current applications and these new applications are expected to be able to share information through Dynamic Data Exchange. Although the Macintosh isn't currently a target of the project, a Metaphor spokesperson said that it could be in the future.

The planned graphical user interface for these new applications will be different than existing GUIs but will most likely resemble, and will incorporate a superset of, Presentation Manager and Motif. The Patriot programs will operate on the major PC network systems, such as Novell NetWare, and will possibly have distributed object capabilities.

The new venture hopes to release a specification for its environment next year and a toolkit in 1992.

It's an ambitious project, and IBM and Metaphor officials concede that it will take them two or three years to get it all working. Patriot expects to have its software working sometime in 1993.

— D. Barker

TI's New Printer Technology Does It with Mirrors

Many printer designs, such as those in most laser printers, involve the use of mirrors. But Texas Instruments has developed a new type of printer technology that is taking this approach to something of an extreme. The company's new technology uses multiple mirrors—hundreds, in fact. What's more amazing is that all these mirrors fit on a single silicon chip.

TI's novel printer technology is based on a new type of chip called a deformable mirror device (DMD). It consists of an array of several hundred microscopic mirrors that can swivel, in seesaw fashion, on a tiny axle. By varying the electrical charge around the mirror, TI can change the orientation of the mirror, moving it to one of three positions. The mirror can be completely horizontal or tilted slightly to one side or the other.

TI produces the DMD chip in a new three-dimensional chip-manufacturing process. First a base layer is put down, followed by a layer of aluminum that functions as the mirror. This layer is etched in such a way that the aluminum is arranged in tiny squares, with small

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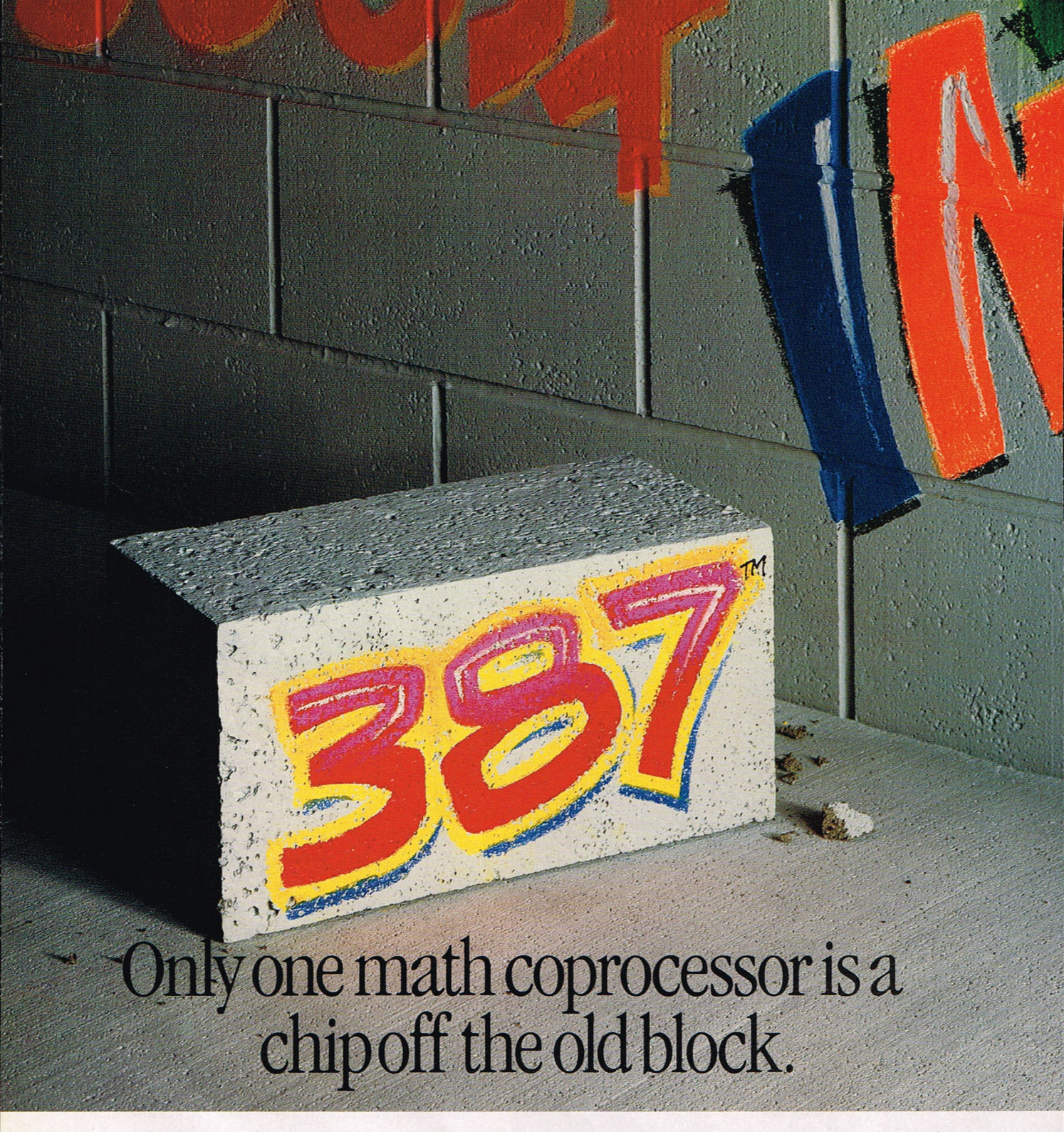
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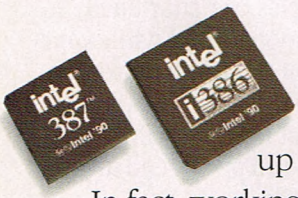
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NANOBYTES

Eager to get the software development ball rolling, **Quarterdeck** has provided "key developers" with alpha toolkits for **Desqview/X**, which combines the company's DOS multitasking system with the X Window System. The two available kits support development for Desqview/X using standard X11 libraries and OSF Motif libraries. They are "stable enough" for developers to begin application development cycles, Quarterdeck said. The company plans to soon release a kit for Xview, based on Sun's Open Look. Desqview/X is supposed to be commercially ready in early 1991.

Japanese companies are apparently planning to produce the **next two generations of DRAM chips** on 8-inch silicon wafers. Because bigger wafers yield more parts, this should result in faster production of 4- and 16-Mb DRAMs through bigger volumes. An 8-inch wafer of silicon has nearly twice as much surface area as the 6-inch wafers now commonly used. According to reports from Japan, **Toshiba** is expected to start its 8-inch line for 4-Mb DRAMs soon. **NEC** plans to start testing this year or early next year and expects to have its 8-inch line operational by 1992.

According to figures from the Japan Electronic Industry Development Association, half of the 327,000 laptop computers sold in Japan this spring (April to June) were of the **notebook** variety.

Incompatibilities between applications running under various Intel-based versions of Unix should be eliminated by the **new edition of the Intel Binary Compatibility Specification**. Intel, AT&T, and The Santa Cruz Operation say they'll collaborate on a new specification that will enable developers to write but one version of an application instead of one for each Unix variant. Developers working with AT&T Unix System V/386 release 3.2 or 4.0, SCO Unix System V/386, SCO Xenix 386, or Open Desktop will be able to have their applications run under any 386- or i486-based operating system that complies with the new binary specification.

axles projecting from two opposite corners. Then TI uses a combustion process to remove the material under the main body of the mirrors. The result is that the mirrors are supported only at two corners and can swivel freely. TI officials admit that this manufacturing process is complex, but the company hopes to eventually produce 2-D arrays containing thousands of mirrors. These could be used in a new type of video display.

TI's first application of the technology will be in a printer. The company has created a chip that contains 840 mirrors arranged in a linear array. The DMD chip will be used somewhat like an LCD array in some page printers, selectively letting tiny beams of light hit a xerographic print drum. TI says that a DMD printer will have 10 percent fewer moving parts than an equivalent laser printer. TI also claims that the DMD chip will be cheaper to manufacture than a large LED or LCD array.

Because it can shorten the amount of time that a mirror is "on" for each pixel, the DMD chip will enable a printer to generate variable-size pixels, thus producing true gray scales. By contrast, a laser beam must scan across an entire row of pixels and conceivably has less time on each pixel in which to vary its brightness.

The first DMD printer will be used in one of TI's most successful printer markets: the airline industry. The device will be used to print the new ATB (automated ticket/boarding) tickets, which look somewhat like computer punch cards. TI claims that such a printer will be able to output 40 tickets per minute at a resolution of 240 dpi. TI officials say they're not sure when this new printer will be available.

— Rich Malloy

AMD Accelerates RISC Line with FPU

Advanced Micro Devices says its new 32-bit RISC processor, the Am29050, will significantly speed up such devices as color laser printers, graphics boards, optical character recognition scanners, X Window System terminals, and imaging systems. To create the new chip, AMD has essentially added a pipelined FPU to its 29000 processor, currently embedded in many graphics-intensive products, including Apple's Macintosh Display Card 8•24 GC, in which it accelerates QuickDraw screen-drawing operations.

Running at its peak of 40 MHz, the 29050 can perform arithmetic operations (IEEE-compatible single- and double-precision) at a top speed of 80 MFLOPS, AMD claims, putting it in the same MFLOPS league as Intel's i860.

The new chip is code- and pin-compatible with the 29000, so applications tailored to that processor will be able to run on the 29050 without any changes, AMD says. In "floating-point-intensive situations," those applications will be faster "by a factor of four," according to an AMD spokesperson. The chip has a 64-entry memory management unit, a 1024-byte instruction cache, support for burst-mode access, and a three-address instruction architecture. The processor will be available in 20-, 25-, 33-, and 40-MHz models.

Although Apple hasn't yet committed to using the new AMD chip, a member of the graphics hardware design department said that the company would like to have the floating-point capabilities that such a processor will offer. "With floating-point, we could do some of the transforms for 3-D drawing faster," he said. "QuickDraw is 100 percent integer right now, but if we wanted to go to 3-D coordinates, if we wanted QuickDraw to have a 3-D architecture, floating-point would be necessary." Apple officials have said one reason they put the 29000 on the 8•24 card is its "growth path"; in other words, because they're plug-compatible, future members of the 29000 family could easily replace the current chips.

— D. Barker

Intel Designs an SX for Laptop Computers

Intel (Santa Clara, CA) has developed a new version of its 386SX processor that's built for laptops and other portable computers. The new 386SL Microprocessor SuperSet is essentially a microprocessor with a chip set to back it up. The 386SL includes critical design changes that extend the 386 architecture to add advanced power management features at the processor level.

The SuperSet consists of the 386SL processor and the 82360 I/O chip. The chips operate at 20 MHz only, matching the highest speed of the 386SX, which

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In fact, John Dvorak calls MemoryMAX nothing short of "amazing."

The Press goes on to mention that because DR DOS 5.0 is fully DOS compatible, you can run all your current DOS applications. And because it is easy to install and requires no hard disk reformatting, upgrading to DR DOS is simple. Since DR DOS 5.0 also includes ViewMAX™, a graphical interface, DOS is easier than ever to use.

Now if we could just get a word in edgewise, we would simply like to add that DR DOS 5.0 is available now. Call your local dealer today.

DR DOS 5.0

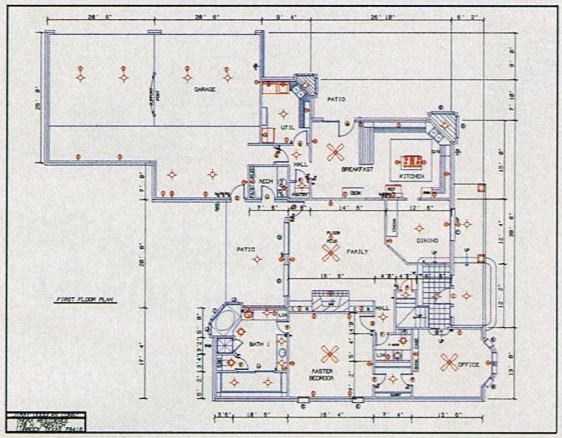
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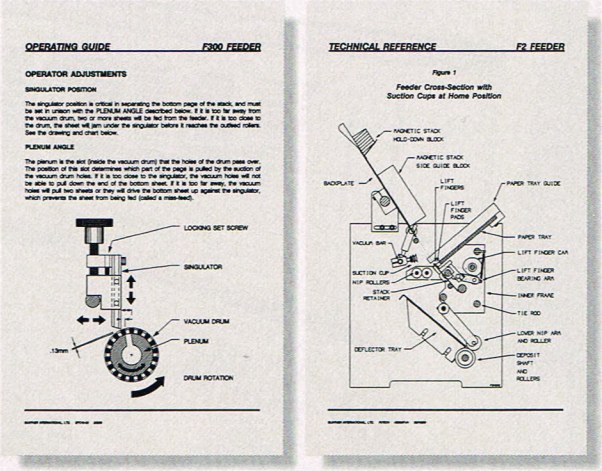
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Circle 109 on Reader Service Card

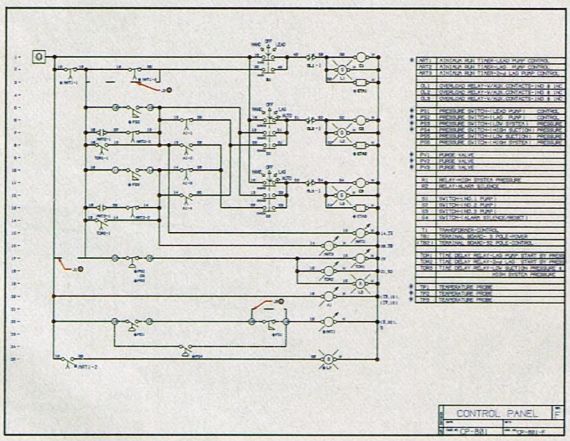
WHAT MAKES A BEST



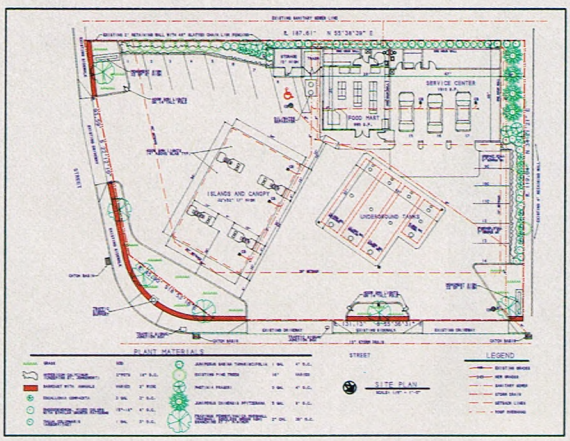
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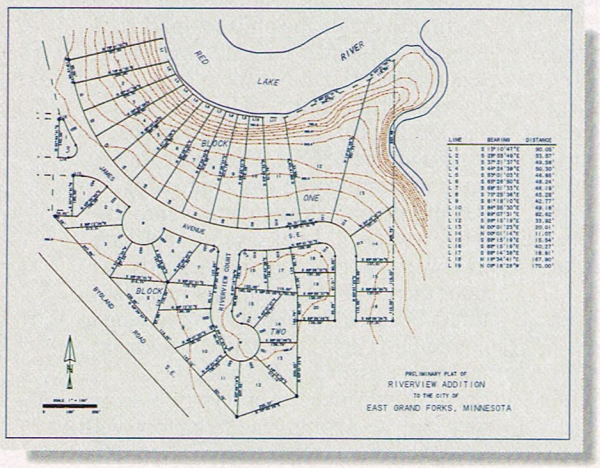
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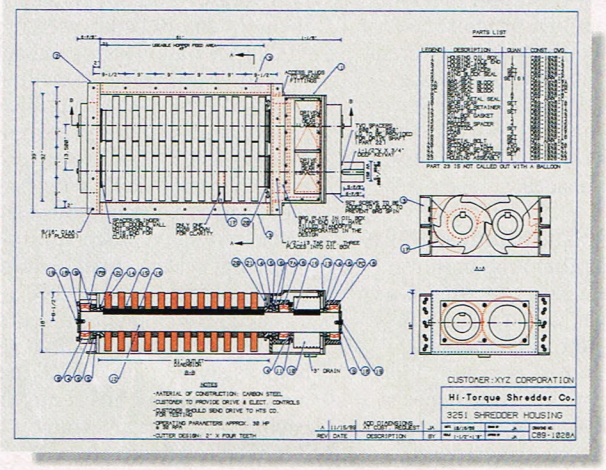
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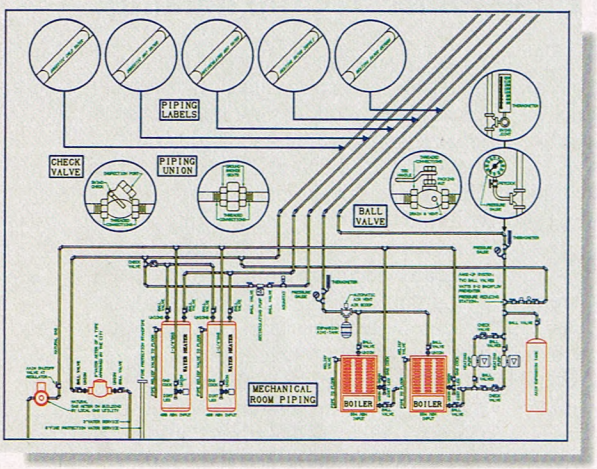
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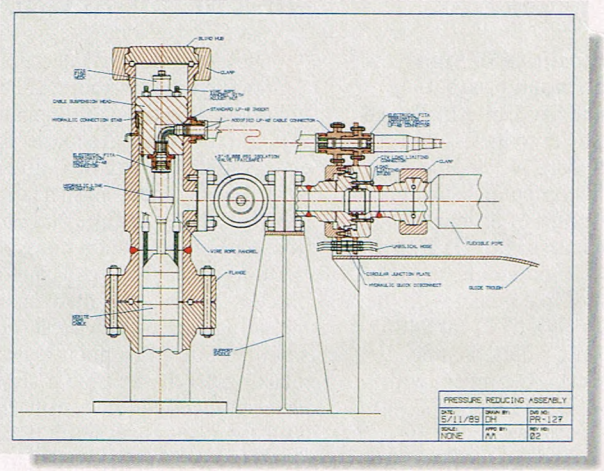
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Circle 143 on Reader Service Card (RESELLERS: 144)

NANOBYTES

National Design, Inc. (Austin, TX), plans to bring out this month a **TMS34020-based VGA card** with the lowest price we've seen yet on a board using Texas Instruments' latest graphics processor. The new Volante board will sell for $995, according to an NDI official. The card is designed to work in different graphics environments, including Windows, 8514/A, TIGA, the X Window System, and CGI. The boards will also ship with AutoCAD drivers from Panacea.

Share or LAN? The **Multiuser DOS Federation** is promoting multiuser PCs as an alternative to LANs. One MDOS member says it's "a myth" that LANs are the only way for groups of computer users to work together. The organization hopes to establish standards for multiuser computing. Among the charter members are representatives of Digital Research, Theos Software, SunRiver, DigiBoard, Alloy, and Viewport International.

The **National Institute of Standards and Technology** says its **Computer Security Bulletin Board** is now much easier to access and navigate. The board is a source of information on computer security, from bibliographies of articles to listings of seminars. The NIST also posts information on incidents such as virus attacks. To connect with the BBS, dial (301) 948-5717 (at 2400, 1200, or 300 bps; 8 data bits; no parity; 1 stop bit). To connect with the help squad, dial (301) 975-3359.

Paper is still the primary **information storage medium**, according to a survey of information managers conducted by Du Pont (Wilmington, DE). Almost half the polled attendees at the Association for Information and Image Management conference said they use hard copy as their main means of storing documents and drawings. About half that many said they use microfilm and aperture cards. Only 11 percent use optical disks, but 40 percent said they see rewritable optical disks as the next big thing in storage. As for their biggest management challenge, almost half said it's finding the information they're looking for.

the 386SL closely resembles in performance terms. Intel has added a hardware-level interrupt and a new memory-address space. These are reserved for a new interrupt, called the system management interrupt (SMI). Using a system management handler, hardware companies will be able to access reserved system management memory and I/O addresses.

The SMI allows suspend and resume operations, peripheral standby, CPU speed control, uninterruptible power supply capabilities, and programmed extensions by OEMs to cover almost any other imaginable power management activity. Despite this extra logic that can remove processor time from the operating system, Intel claims that the 386SL outperforms a 386SX.

The 386SL includes a main-memory subsystem controller with a 32-MB address space, an EMS 4.0 memory controller, an AT bus controller, a full cache controller, and support for the 80387SX math coprocessor. The companion device, the 82360SL, supports CPU, memory, and peripheral functions, as well as providing programmable features to manage power to prolong battery life. Intel provides a set of low-power support logic chips.

The 386SL and 82360SL are sold separately and cost $176 and $45, respectively, in quantities of 1000.

The new SL line signifies that Intel is starting to attack the chip set market. Several companies currently sell chip sets that offer many of the power management features of the 386SL in support logic devices designed to be used with the 386SX. However, Intel has something those companies don't: the ability to tie those features into the processor itself. Intel says its approach to power management is inherently safer than that of the chip set manufacturers because the 386SL isn't having to continually fight for control of memory, interrupts, and the CPU with the operating system and applications. The new chip set should lead to laptops with longer battery lives by late next year.

— Owen Linderholm

New Material Could Ease Pains of Chip Making

They're called arylated poly (p-phenylene sulfide) (APPS) polymers, and they could change the way microcircuits are made. Researchers at the University of California at Berkeley say these new materials could greatly reduce the time and complexity involved in fabricating chips.

Building microchips is a tedious process that takes as many as nine steps, including coating silicon slices with silicon oxide and a photoresist polymer, masking off the areas that are to become electrically conductive from those that aren't, printing the circuit pattern onto the silicon, exposing this sandwich to light (*photolyzation*), etching away the nonconductive silicon oxide, and stripping off the photresist.

But with these new polymers, that process can be simplified "to two or three steps," says Berkeley chemistry professor Bruce Novak. The new polymers normally function as insulators, but the Berkeley team led by Novak discovered that when the materials are exposed to light, they become semiconductors; masked-off areas remain insulators. Thin films made of APPS can be laid over a circuit pattern and turned into microcircuits, with the exposed areas working as conducting wires. The thin film basically becomes a microcircuit after being photolyzed, so no additional processing is necessary, Novak says. Because the photolyzed films are capable of conducting electricity, chip makers would no longer have to use silicon wafers; APPS films could be put down on different kinds of materials.

APPS films could also end up on your computer screen. Because the films are so thin (0.25 micron) and optically transparent, they could be painted directly on the screen, like a coat of microcircuits. Current running through the circuits would generate visual patterns, Novak says.

— D. Barker

ARE YOU AN INNOVATOR? *If you, your company, or your research group is working on a new technology or developing products that will significantly affect the world of microcomputing, we'd like to write about it. Phone the BYTE news department at (603) 924-9281. Or send a fax to (603) 924-2550. Or write to us at One Phoenix Mill Lane, Peterborough, NH 03458. Or send E-mail to "microbytes" on BIX or to "BYTE" on MCI Mail. An electronic version of Microbytes, offering a wider variety of computer-related news on a daily basis, is available on BIX.*

In Redondo Beach, California . . .

You'll find breathtaking ocean views, sensational surfers and Gateway 2000 computers.

Dive 'N Surf, famous for Body Glove® fashions and watersports equipment, is a member of the growing family of Gateway 2000 customers in California. Dive 'N Surf Computer Systems Manager Graham Pask chose a Gateway 25 MHZ 386 machine for his network server. The system runs point-of-sale, inventory control, word processing and desktop publishing software.



Graham Pask, Computer Systems Manager for Dive 'N Surf, and his Gateway 2000 25 MHZ 386 network server.

"I decided to buy a Gateway 2000 system because they had everything I wanted for a good price," said Graham. "But what really impressed me was the service. I had a problem with my 3 1/2 inch drive so they sent me a new drive the very next day."

Graham said he was so happy with his Gateway system at work that he bought a Gateway 2000 25 MHZ 386 Cache machine for his home.

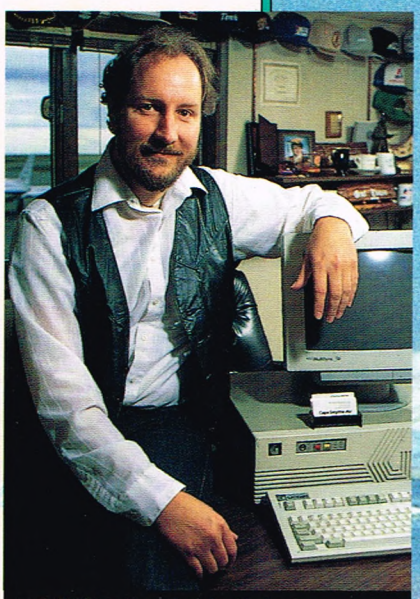
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"You've got a friend in the business."

Until well after sunset, surfers ride the big waves on the Pacific Ocean near Redondo Beach, California.

And In Barrow, Alaska . . .

Over 300 miles north of the Arctic Circle, you'll find polar bears, seals, whales, walrus, lemmings, snowy owls and what appear to be the largest mosquitoes in existence. On a summer afternoon you'll also see parka-clad tourists walking among local residents in shorts. And of course you'll find a good Mexican restaurant and Gateway 2000 computers.



Jeff Frier, Cape Smythe Air Service, with his Gateway 2000 386SX.

Cape Smythe Air Service, a regional commuter airline serving Barrow, Kotzebue, Nome and remote villages in Alaska, has one of several Gateway 2000 computers operating in Barrow. Jeff Frier, Cape Smythe's accountant, chose a Gateway 2000 386SX to run spreadsheet, data base and accounting applications.

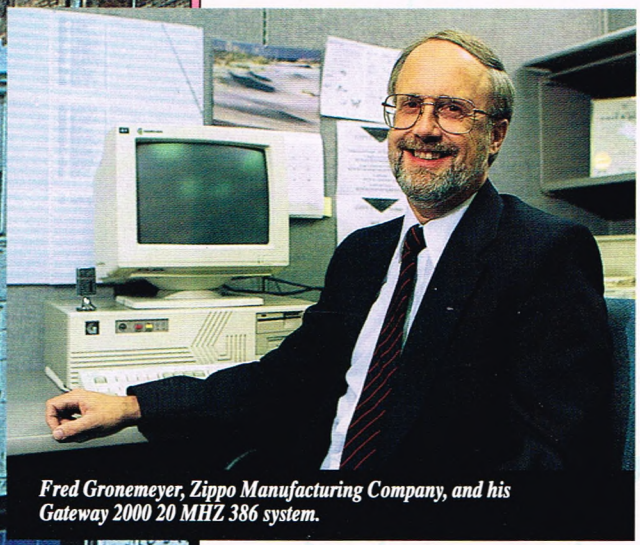
"I was trying to decide between Gateway 2000 and a competitor," Jeff commented, "so I talked to a person who owns the competitor's system. He was disgruntled about the service he received from them. Then I talked to another person in Barrow who has a Gateway and she was happy with the product and service. The choice was pretty obvious -- when you're doing business in a remote area, the most important things a vendor can offer are reliability and good service."

Jeff said he also appreciated Gateway's features and price. "When you have to pay $6 a gallon for milk, it's nice to find a bargain somewhere." Jeff plans to buy another Gateway 2000 computer in a few months .

On a mid-July day in Barrow, Alaska, fishing boats weave in and out of icebergs on the Chukchi Sea.

In Bradford, Pennsylvania . . .

You'll find a charming small city nestled in the Allegheny National Forest. The city's most prominent local business is the Zippo Manufacturing Company, where you'll find 18 Gateway 2000 computers in use.



Fred Gronemeyer, Zippo Manufacturing Company, and his Gateway 2000 20 MHZ 386 system.

Zippo is known around the world for its windproof lighter made famous during the second World War, although today the company's product line includes many other specialty advertising items. Fred Gronemeyer, Systems Analyst for Zippo, chose Gateway 2000 as the company's standard PC.

"We needed to set standards for PC's and software to make the most efficient use of these tools," Fred remarked. "We started out with PC's from different manufacturers, but once I tried Gateway I was convinced we could get the highest quality, most reliable machines at the best price from Gateway 2000. I was also impressed by my salesman and the tech support people I've dealt with at Gateway."

Fred said by the end of the year Zippo will be running every system Gateway 2000 makes, from 286's up to a 486 and everything in between.

Main Street, U.S.A., is located in Bradford, Pennsylvania.

And In New York City . . .

You'll find your senses overwhelmed by the countless sights and sounds of this one-of-a-kind city. And of course you'll find thousands of Gateway 2000 computers here.

One New York City Gateway 2000 owner is independent record producer and engineer Jim Rondinelli. Jim uses his Gateway 2000 386SX with a sophisticated player piano sequencer to compose music.



Jim Rondinelli, independent record producer and engineer, with his Gateway 2000 386SX.

"The software I use is written for the Mac and for IBM compatibles," Jim said, "but it runs much better on IBM compatibles. And it runs best of all on my Gateway. I travel often and I've used my software on a lot of other machines. They don't even compare with my Gateway 2000."

Jim said he bought his Gateway 2000 because it was equipped for the real world with ample hard drive capacity and RAM, both sizes of disk drives and color VGA graphics.

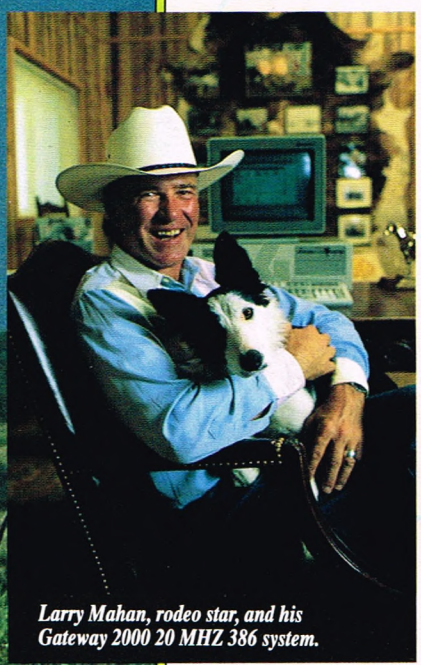
"It's the fastest file transfer computer I've ever used," continued Jim, "plus it ran right out of the box. One afternoon and I was fully functional on a brand new system."

The streets of Manhattan are a constant blur of activity.

Near Camp Verde, Texas . . .

You'll find the magnificent Hill Country of Texas with rattlesnakes, prickly pear cactus and huge cattle ranches. You'll also find Larry Mahan and his Gateway 2000 computer.

Larry Mahan is to rodeo what Jack Nicklaus is to golf. He is Six Times World Champion All-Around Cowboy and is a member of the Cowboy Hall of Fame. But Larry also runs a cattle and horse ranch and is involved in a western apparel manufacturing company and a new Southwestern foods company. His Gateway 2000 20 MHZ 386 system is an integral part of his business operations. "We run cow and calf software for our Longhorn cattle herd," Larry said. "You can't really manage a livestock business efficiently without it. Plus we do accounting, spreadsheets and word processing on our Gateway 2000 computer."

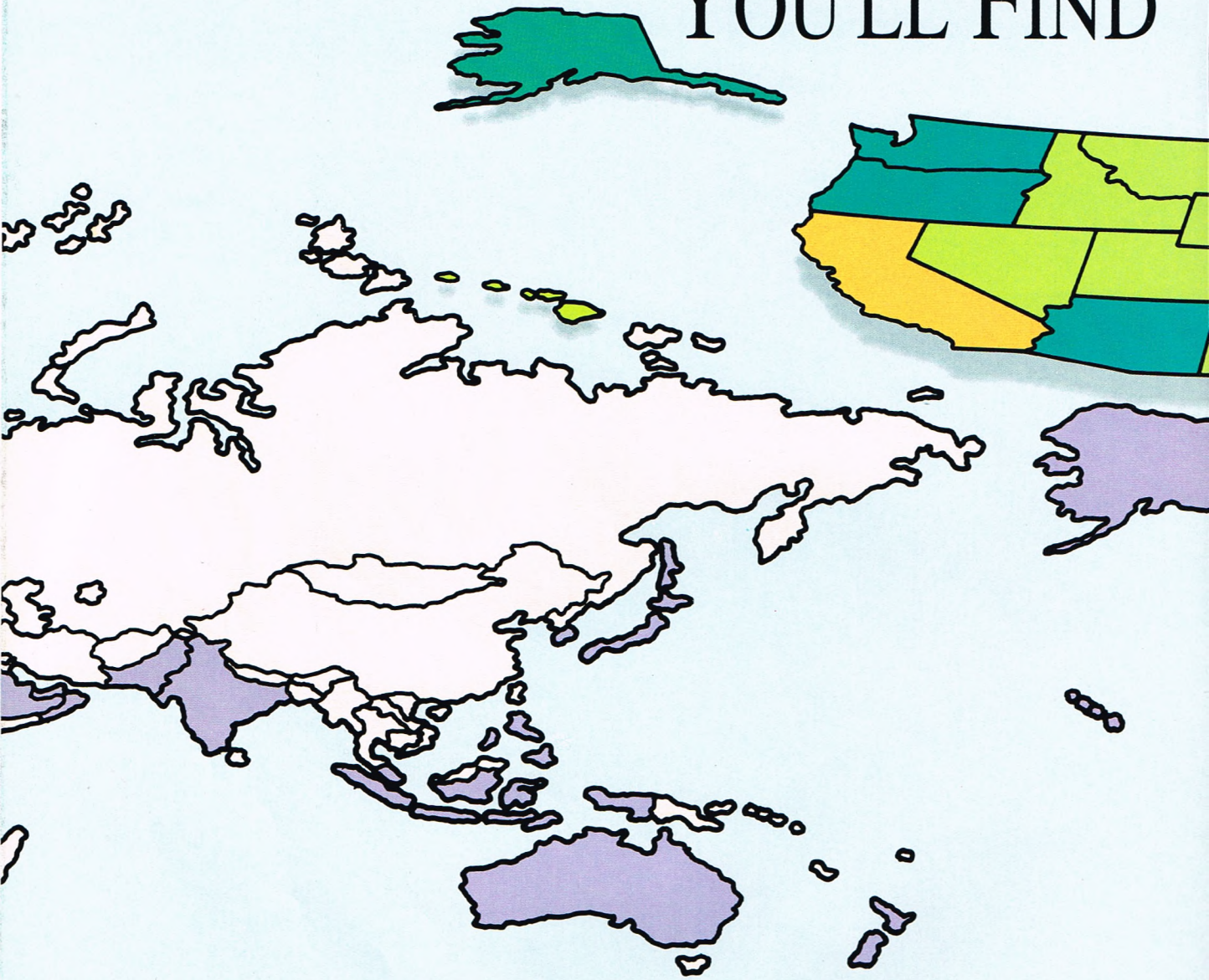


Larry Mahan, rodeo star, and his Gateway 2000 20 MHZ 386 system.

Asked why he chose Gateway 2000, Larry said, "They had the best features and price – and I thought a computer company that puts pictures of cattle in their ads had to be my kind of people. And I was right. The people I've talked with at Gateway 2000 are honest-to-goodness nice folks. It's a pleasure doing business with them."

Larry Mahan raises registered Texas Longhorn cattle.

ACROSS THE COUNTRY YOU'LL FIND

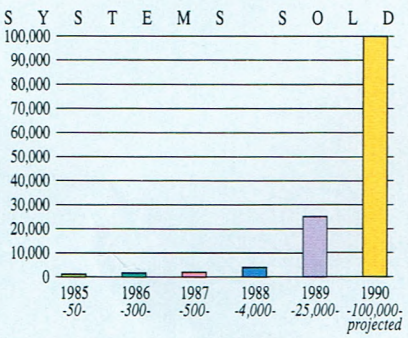


You'll find so many Gateway 2000 computers in so many places today because people everywhere know a good value when they see one. In all 50 states and in over 70 foreign countries, thousands of people are comparing prices, quality and service – and choosing Gateway 2000.

But value alone doesn't explain how a little company in the Midwest, started just five years ago, managed to outdistance hundreds of other companies, selling more systems through the direct market channel today than any other PC manufacturer in the country.

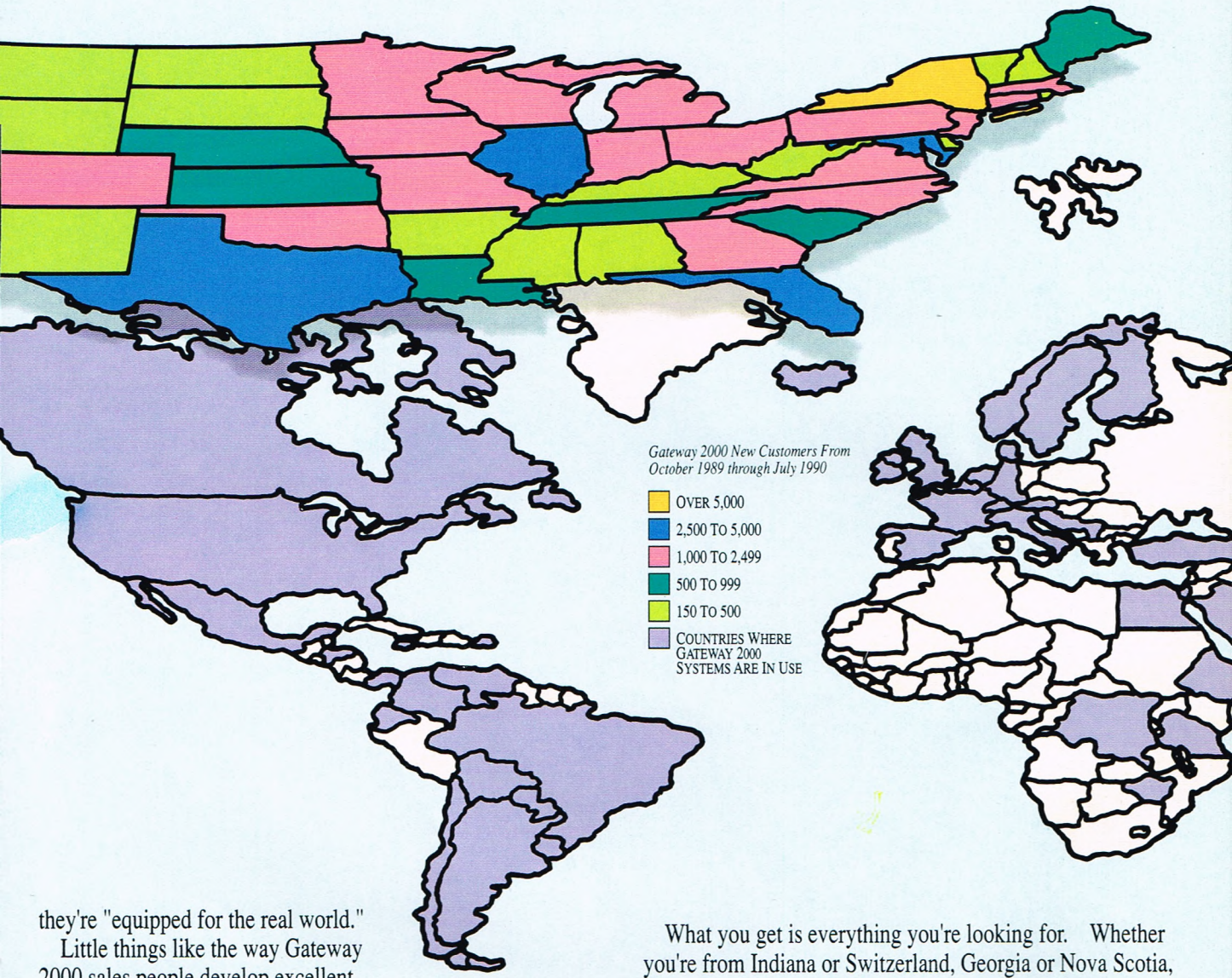
The explanation is that the company has always maintained a small company attitude. With Gateway 2000, you still get the little things you'd expect only from a small firm.

Little things like a positive technical support department. When Graham Pask told his Gateway 2000 tech rep that his 3 1/2" drive didn't work, he received a new drive the very next day.



Little things like the way Gateway 2000 systems are fully loaded with all the features you want. Jim Rondinelli bought a Gateway 2000 computer because

AND AROUND THE WORLD, GATEWAY 2000!



they're "equipped for the real world."

Little things like the way Gateway 2000 sales people develop excellent business relationships with their customers. Fred Gronemeyer tried his first Gateway because he was impressed by his sales person. Eighteen systems later, Fred is still impressed by his sales person.

And the biggest little thing of all is the feeling you get when you deal with the people at Gateway 2000. As Larry Mahan said, "they're honest-to-goodness nice folks."

Compare prices, quality and service. Then add up the little things you get from small town people running an old-fashioned, high-tech business.

What you get is everything you're looking for. Whether you're from Indiana or Switzerland, Georgia or Nova Scotia, you've got a friend in the business at Gateway 2000.

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"You've got a friend in the business."

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- ESDI Cache Controller
- 16 Bit VGA with 512K
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- 1 Parallel & 2 Serial Ports
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- MS DOS 3.3 or 4.01
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LETTERS

and Ask BYTE

Computer-Aided Independence

As a disabled computer user, I would like to thank you for "Opening Doors for the Disabled" by Joseph J. Lazzaro (August). Lazzaro provides an invaluable service by making more people—both disabled and nondisabled—aware of the full scope of adaptive technology.

He and I both have a vital interest in this area, since without adaptive technology neither of us could function as independently as we do. I am a quadriplegic, and I work (and play) on a computer 8 hours a day using the Magic Wand Keyboard, a miniature IBM-style keyboard that my husband originally designed for me. This keyboard works with a wand and requires no strength or dexterity. We now sell the keyboard, and earlier this year, our company was awarded a grant for $30,000 from the New York State Science and Technology Foundation for projects relating to the keyboard's use as an educational/vocational tool.

Anyone interested in obtaining information on adaptive computer technology should contact the Trade Center in Madison, Wisconsin, at (608) 262-6966, and the IBM National Support Center for People with Disabilities in Atlanta, Georgia, at (800) 426-2133.

More articles like Lazzaro's are needed to reveal exactly what is available and how profoundly computers can affect a disabled person's life. At stake are not spreadsheet performance and networking capabilities, but basic needs of self-realization.

Susan Crouch
Spring Valley, NY

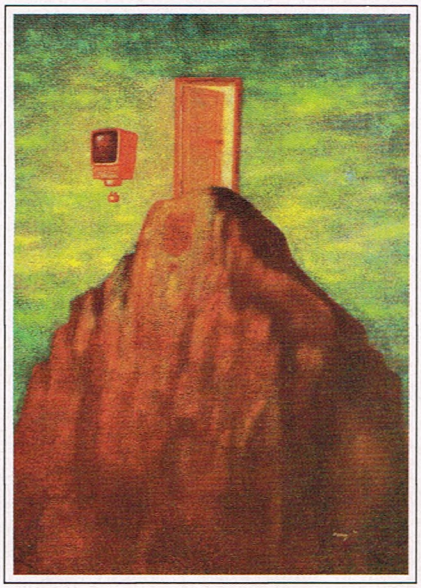
Wolf in Fly's Clothing

I enjoyed "The Flight of the Bee Wolf" by Ben Smith (June).

I would like to suggest one correction. The bee wolf is not a fly, which would be found under the order *Diptera*. It is found in the order *Hymenoptera*, which contains sawflies, parasitic wasps, ants, wasps, and bees.

The bee wolf, taxonomically, is located under the family *Sphecidae*, subfamily *Philanthinae*, tribe *Philanthini*, which contains 29 species in North America. They are also known as bee-killer wasps.

I do not want to take away from your efforts to produce interesting articles. I



just wanted you to know that entomologists do read BYTE through to the last page. I have a great fascination for both insects and computers.

Harry L. McMenemy
Memphis, TN

IBM Bashing?

Am I the only one who finds Joel S. Moskowitz's Stop Bit ("Quest for a Mouseball," July) just a wee bit strange?

First, he blackmails IBM into giving him a brand-new mouse—just because he lost the parts of his old one—or else he'll write a big exposé about the fact that this part does not have a part number! For the nuisance value and for gracious customer relations, IBM accedes to his "request."

And then he writes the article anyway. This, from a lawyer? First blackmail, then breach of contract? No wonder the world delights in telling jokes about the greed and venality of the legal "profession."

Lucien R. Greif
Chappaqua, NY

WE WANT TO HEAR FROM YOU. *Please double-space your letter on one side of the page and include your name and address. Letters two pages in length or under have a better chance of being published in their entirety. Address correspondence to Letters Editor, BYTE, One Phoenix Mill Lane, Peterborough, NH 03458. You can also send letters via BIXmail c/o "editors."*

Your letter will be read, but because of the large volume of mail we receive, we cannot guarantee publication. We also reserve the right to edit letters. It takes about four months from the time we receive a letter until we publish it.

Bridge Work

In Jon Udell's review of a program called Bridge ("Windows Shopping: 3.0 Applications Take Shape," July), he states that the program "activates the clock, . . . resizes it, and moves it to the lower right-hand corner of my screen. . . . There's no straightforward way to do this on a Mac or in any of the Unix graphical user interfaces."

This, at least with respect to Unix, is false. Put the following line in your log-in or profile file:

```
xclock -display unix:0.0 -geometry
50x50-50-50 &
```

This line will load an xclock, using Unix-domain sockets, on screen zero of display zero, with a window size of 50 by 50 pixels and the window placed in the lower right-hand corner of the screen. If xclock follows the *Inter-Client Communications Conventions Manual* (and as an X Consortium–distributed demo, it ought to), then it will pop up under any compliant X11R4 window manager without your intervention.

Garrett A. Wollman
South Burlington, VT

What you say is true: An X Window System manager can indeed control the initial size and location of an application's window. My clock example, in retrospect, wasn't well chosen. (Even under Windows, there is no need to resize the clock's window, since the clock can update its display while running as an icon.) The more interesting capability of Bridge, as I pointed out, is its ability to launch and interact with a collection of graphical applications under programmatic control. A Bridge program can, for example, launch a spreadsheet and a word processor and then cut a range of numbers from the spreadsheet and paste them into the word processor. Bridge uses graphical programs as components of meta-applications, just as Unix shell scripts and DOS batch files use command-line programs.

Nothing precludes the invention of such

a graphical scripting language for X Window, but it's my understanding that it hasn't happened yet. I have no doubt that resourceful X Window aficionados will soon bring graphical user interface scripting to Unix. And, of course, Mac users are anxiously awaiting the scripting features promised for System 7.0.

—Jon Udell

ESDI Explanation

I am curious as to how author Roger C. Alford arrived at the conclusion that no one uses hard sectoring ("The Evolution of ESDI," June).

Where I work, we use large ESDI drives from Fujitsu and Micropolis, and controller cards from SMS Technologies and PSI Technologies (HyperStore), and everything we buy is hard-sectored at the factory. In fact, on the SMS Omti8640 and the HyperStore, no option exists for soft sectoring.

Although soft sectoring is preferable, hard sectoring seems to be the norm.

Dave Harrison
Los Angeles, CA

My statement that hard sectoring is not generally used in ESDI implementations is incorrect. As you point out, hard sectoring is still common in modern ESDI implementations. The important thing to note is that ESDI supports both soft and hard sectoring. I apologize for any confusion this may have caused.

—Roger C. Alford

Corvus Responds to Review

BYTE reviewed our ReadyNet in its Product Focus "Networks of Peers" (June). We would like to address the complaints of your editors.

In the cabling connections for the 1-megabit-per-second ReadyNet, you open a tap box and insert pretinned wires into a punch-down block. While this is more difficult than plugging the cable directly into the tap box (as you do with the 4-Mbps version), it is no more difficult than plugging in a stereo speaker.

In the version that BYTE tested, it is true that ReadyNet did not support sector sizes larger than 512 bytes for volumes larger than 32 megabytes. This has been changed in the latest version, which shipped in June.

If you type in connections from the command line, the syntax has one more parameter than the standard MS-NET syntax that most other systems use. However, the ReadyNet manual in no way advises users to type in connection strings from the command line. ReadyNet provides a simple menu program called Quick Connect that eliminates typing in command-line strings. And since Quick Connect provides the option of automatically making the connections after every reboot, there is no need to generate batch files for connection loading. The BYTE editors seem to have overlooked Quick Connect.

It is false that there is no way to change node or user names. You can change them using NetView, another network management program that the BYTE editors overlooked.

It is incredible that the BYTE editors did not notice the print spooler. The print spooler is automatically set up on the first server, and it can be set up using Quick Connect on any other node as well. The queue manager was left out of the original ReadyNet 1-Mbps version, but it has always been available from Corvus on the technical-support BBS. It is currently available in the 4-Mbps and the new 1-Mbps versions.

ReadyNet is designed for use in a small office environment by people not familiar with network operation. I am sure that the BYTE editors try very hard to be fair in their evaluations, but perhaps their technical proficiency led them to overlook some of the features that have been included for the novice.

Janel Killheffer
Marketing Manager
Corvus
San Jose, CA

We agree that you don't need an electrical engineering degree to install ReadyNet's 1-Mbps tap boxes. Still, these were the only nonmodular connections that we encountered in the review. We don't understand why the entry-level version of a network advertised as "self-installing" does not supply modular connectors.

We are glad to hear that the latest version of ReadyNet can work with non-512-byte sectors and volumes larger than 32 MB. More and more vendor versions of MS-DOS have such characteristics; it is critical to support them.

It is true that Quick Connect automates connections, and that you can specify those connections by way of a menu system. However, you use that menu system to piece together connection strings expressed in terms of concepts (i.e., plugs, sockets, and modules) that confused us and that we think will confuse novices even more.

We didn't say that ReadyNet won't let you change the default user names—it will. We did not find a way to change the names of workstations and printers. We raised this question with a Corvus representative. He told us that printer names are indeed fixed and that workstation names can be modified only by means of a workaround.

We are glad that the 1-Mbps version of ReadyNet now includes the queue manager. It was, as you say, left out of the original 1-Mbps version, and we did not receive a supplementary copy by press time.—Jon Udell and Rob Mitchell

The Problem with Toner

We would like to clarify two points about the Kyocera F-1000A laser printer reviewed in your July Product Focus, "Laser Printers Get Personal."

From the article's narrative, it is clear that the first toner was installed incorrectly. The toner is never opened and poured into the hopper as described. As instructed on the top of the cartridge, you place the cartridge in the developer and keep it there until it is empty. Once the cartridge is locked in place, you pull a Mylar strip from the right to release the toner into the developer.

We strongly believe that by manufacturing the entire printer, including the engine, we can maintain the highest level of quality in our products, for which Kyocera has been recognized for over 30 years. This quality has also been recognized by both Unisys and Mannesmann Tally, which chose to use our printer engines.

Michelle Christian
Marketing Communications Manager
Kyocera Unison
Alameda, CA

We did follow the procedure you describe. We locked the toner into place, pulled the Mylar strip, and released the toner into the developer. We were then required to remove the toner receptacle before replacing the hopper. At that point, we were exposed to any loose toner left in the receptacle. That was the difference. Printers using the Canon engine eliminated the need to deal with the toner at all. Even among those printers requiring separate toner, the Kyocera Unison model was the only one that didn't leave the toner receptacle attached to the toner cartridge. With the other printers, you attach the toner and pull the strip, and the dirty work is done.

We can see the advantages of manufacturing the entire printer. We just think that buyers should make sure that expendables (e.g., toner and drum) and upgrades are readily available. In general, third-party support adds value to any product.

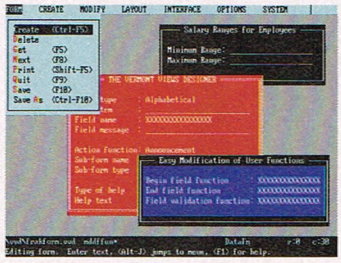
—Stanford Diehl and Stan Wszola

continued

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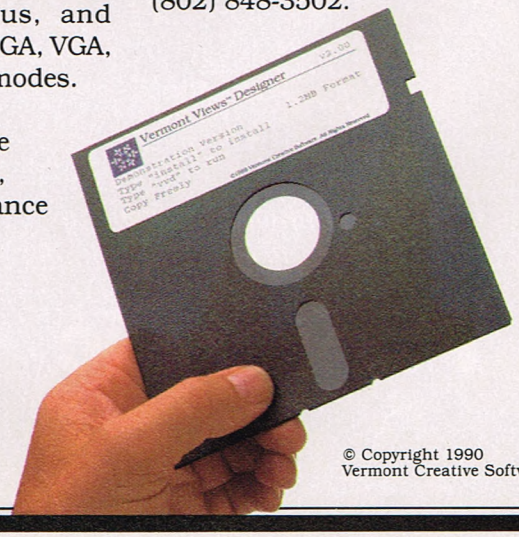
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There are three ways to get everything you expect from a laser printer.

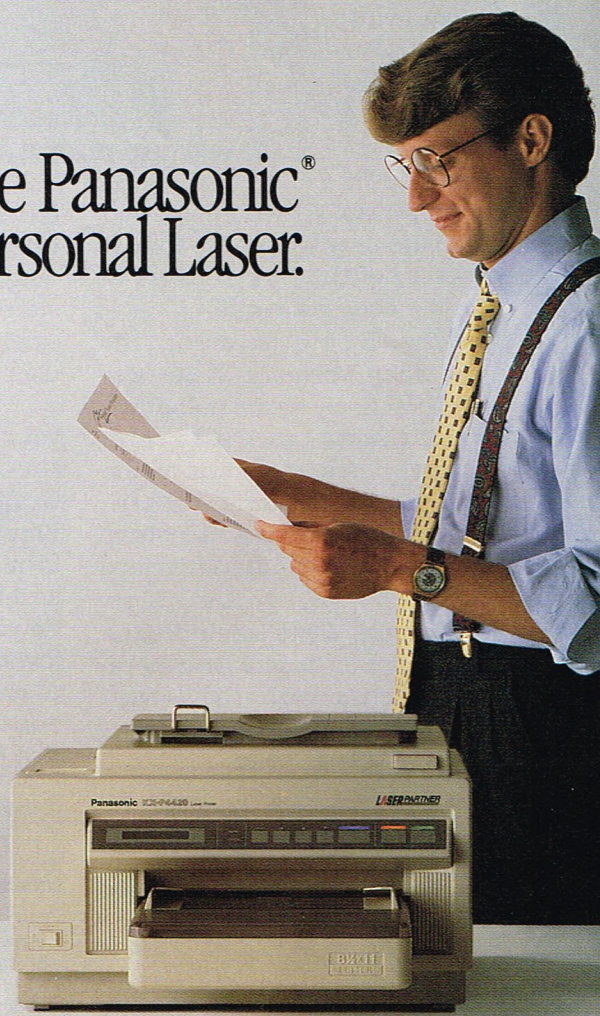
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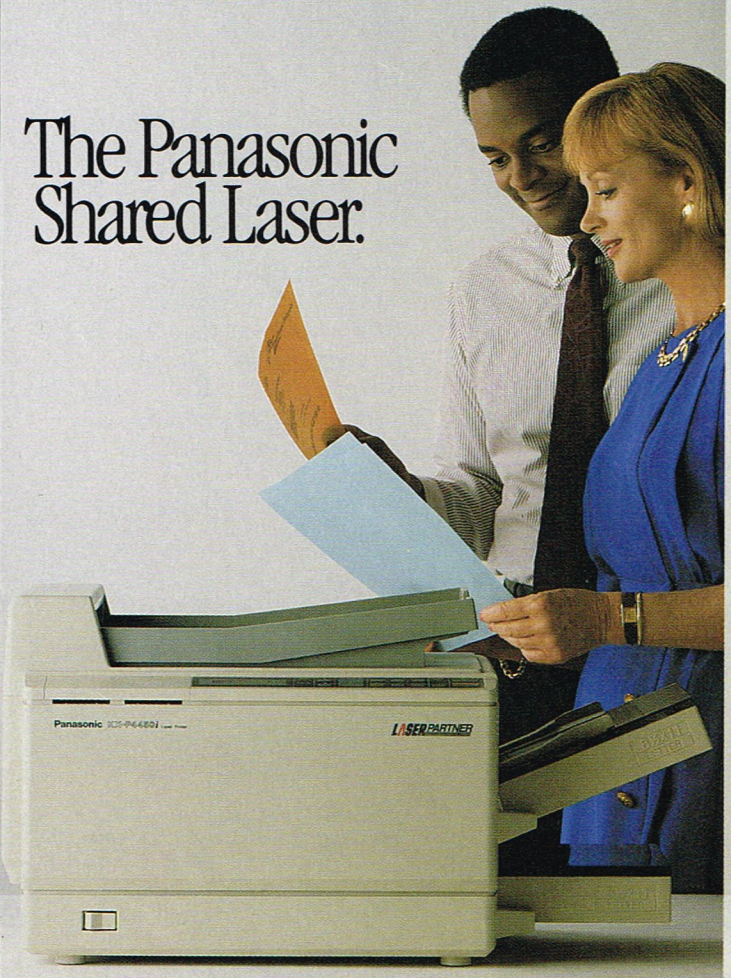
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When you have several people in your department, you need a printer that can handle them all.

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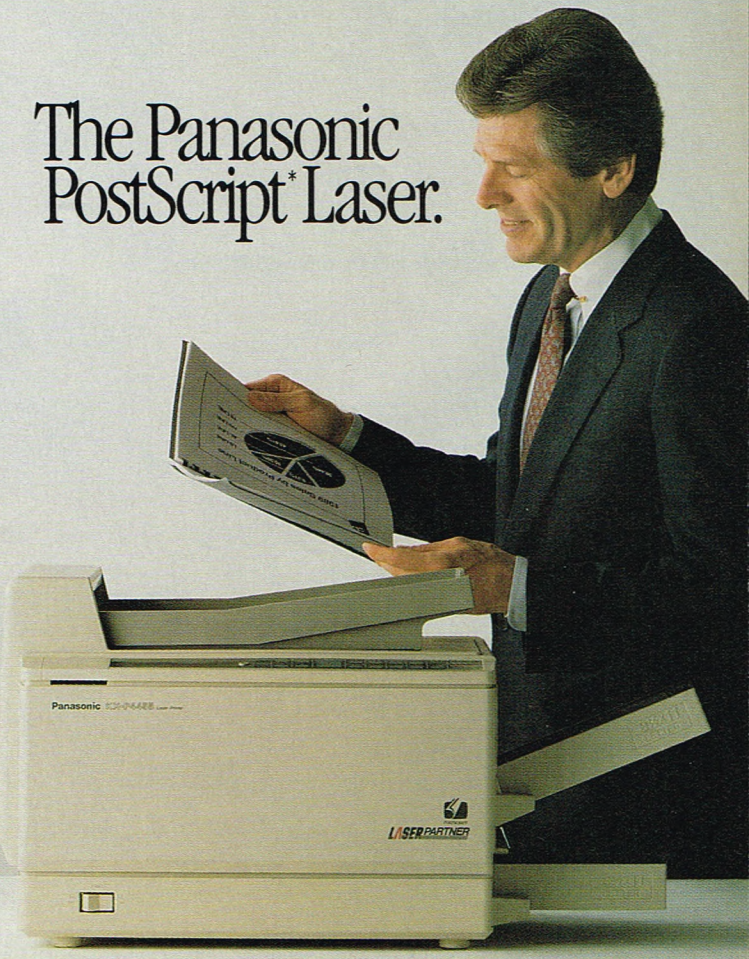
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Resolution: 300 Dots Per Inch.
RAM: 2MB Standard, expandable to 4MB.
Interfaces: RS-232C/422A Serial, Centronics Parallel and Appletalk.*

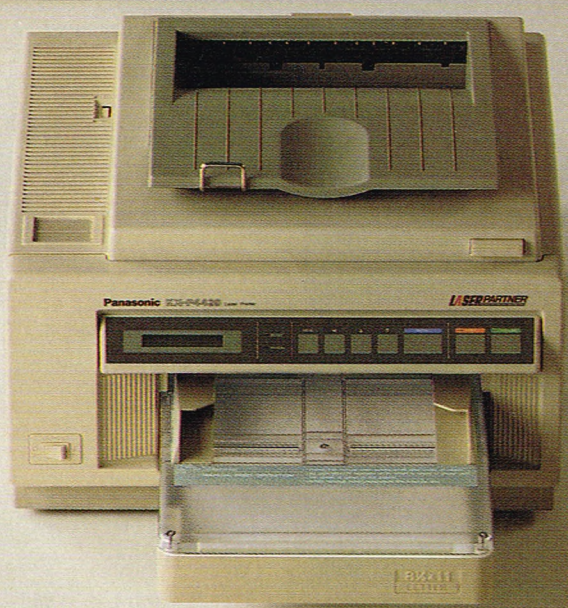


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Compatibility: HP LaserJet Series II, Panasonic, Epson, IBM and Diablo emulations.*
Fonts: 28 Internal Fonts-14 available in both portrait and landscape. Two slots for optional font cards.
Paper Handling: Two 250-Sheet Cassettes with Manual Feed.
Resolution: 300 Dots Per Inch.
RAM: 512K Standard, expandable to 4.5MB.
Interfaces: Centronics Parallel and RS-232C Serial.

The KX-P4420 Panasonic Personal Laser.

Printing Speed: 8 pages per minute.**
Compatibility: HP LaserJet Series II emulation.*
Fonts: 22 Internal Fonts-11 available in both portrait and landscape. Two slots for optional font cards.
Paper Handling: 250-Sheet Cassette with Manual Feed. Face-up and face-down output.
Resolution: 300 Dots Per Inch.
RAM: 512K Standard, expandable to 4.5MB.
Interfaces: Centronics Parallel; Optional RS-232C Serial.



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LPF-BY

Circle 274 on Reader Service Card

ASK BYTE

Like, Squaresville, Man

I am wondering if all present computer systems divide the display into so many square pixels. If high resolution is important, as in animation and CAD, then the square tessellation of the display does not seem to be the best choice.

There are only three regular tessellations of a planar surface: covering the surface with squares, with regular triangles, or with regular hexagons. In any of these cases, circles can be inscribed within each of the polygons of a given tessellation. This results in three different methods of uniformly packing circles on the plane. The sizes of the square, the regular triangle, and the regular hexagon can be chosen so that the circles are the same size for all three methods of circle packing. It is then fairly easy to show that, for a given area of reasonable size, the hexagonal tessellation leads to the greatest number of circles of a given radius.

These circles inscribed within the regular polygons correspond to the beam of electrons that activates each pixel of the CRT (when the brightness is adjusted properly). A circle inscribed in a regular hexagon covers over 90 percent of the area of the hexagon. The same circle inscribed within a square will cover less than 79 percent. Thus, the hexagonal tessellation leads to about 15 percent more pixels for a given area. This should indicate a slightly better resolution for graphics work. (The method of grouping the pixels for the creation of a character set is another matter.)

Thank you for any explanation that you can give.

Lem Chastain
Brooklyn, NY

This is really a question for people who design graphics systems, but I will join you in supposition.

Perhaps the reason behind the rectilinear pixel arrangement has to do with the history of the most common display medium: the CRT. The beam is sweeping left to right in horizontal strokes. If the pixels were shaped as hexagons, the beam wouldn't be able to sweep smoothly across the display. Early TV grew from black and white to color, and then computers began painting pictures on TV displays through graphical display drivers. We have always thought of display coordinates as straight Cartesian (x, y) coordinates, and making the changeover to hexagons might freak people out. Still, the increased resolution might be useful.

With display technology changing on a daily basis, it would be relatively easy to implement your approach in LCD, plasma, or electroluminescent display technologies. Electronically, we drive the displays from banks of memory anyway, so it's just a matter of addressing the data to the right cell. The only real difficulty would be to get programmers to think in hexagons. We would have to rewrite all the line- and circle-drawing algorithms, get new versions of Microsoft Windows and Macintosh Toolbox drivers, and so on. Do any display manufacturers have thoughts on this? It's an interesting idea, and I hope that people remember that they read it here first. Lem, if we receive any royalty checks, we'll be sure to pass them along to you.—H. E.

A Storm in the Port

With IBM XT compatibles, it is a simple matter to switch the turbo mode on or off by reading a port (often at address 62 hexadecimal) and resetting 1 or more bits, depending on the type of board.

I recently purchased an AT compatible with the Texas Instruments AT chip set and Award 286 Modular BIOS 3.03HD. I would like to be able to switch the machine into and out of turbo mode using this technique. Unfortunately, I do not have any information on the speed setting. Do you have any ideas on the subject?

R. D. B. Fraser
Tewantin, Queensland, Australia

Unfortunately, you haven't given me enough information to completely answer your question. The software control over the turbo function is often handled by the keyboard controller/microprocessor on a PC-compatible machine. As you pointed out, it's usually a matter of twiddling a bit or two at an I/O port, usually in the range 62h to 6Fh. According to Award, the company has never made a version of its BIOS for the Texas Instruments AT chip set. Because of that, there's no way that Award can tell you where the I/O port is on your machine; that information would have to come from the motherboard manufacturer. If you want to send your letter anyway, you can reach Award at 130 Knowles Dr., Los Gatos, CA 95030, or by fax at (408) 370-3399.

All is not lost. If your BIOS supports speed-changing through the keyboard (often Ctrl-Alt-+ and Ctrl-Alt-− or Ctrl-Alt-1 and Ctrl-Alt-2), you can find the port by tracing through the BIOS in the debugger. The address of the keyboard handler (INT 09h) is 0000:0024. Get that address (probably in the F000 segment) and disassemble the code. If you are lucky, you'll find an OUT instruction to a port in the 60h–6Fh range. When you find something interesting, write a short test program to twiddle the bits, and see what happens.

Finding that I/O port is a good rainy-day activity, one that should keep you entertained for hours. Be prepared to reboot often; it's likely that if you tweak the wrong bit on the keyboard controller, you'll totally mess up your machine.

—H. E.

Frantically Foraging for Fractint

Would you please let me know how or where I can obtain information on a program named Fractint?

Arthur Trantolo
East Hartford, CT

Fractint is a public domain fractal display program by Bert Tyler and a few other hotshot programmers. Source code and executable copies are available on BIX, CompuServe, and many BBSes; its latest release is version 14.0.

If you have trouble obtaining the program on-line, contact the author at Tyler Software (124 Wooded Lane, Villanova, PA 19085).—S. A.

Missing Manuals

In July 1989, I bought a 20-MHz Arch Tech 386 Tower Computer from Tech Center in Boulder, Colorado, and the system has worked great. My problem is that not all the manuals were in the boxes. I thought you might be able to give me some good ideas on how best to address the problem.

For the last year, I have been trying to get the manuals from the people at Tech Center, but I have had no response from them. I guess that's because they know I am a foreigner, and they think that there is no marketing benefit in helping me. I have thought of addressing Arch Tech directly to purchase the manuals, but I do not want the company to think that I want the documentation to duplicate its system here. Also, I do not have Arch Tech's address.

How should I address this problem?

Francisco Bascuñán Noguera
Santiago, Chile

I'm glad to hear that you're enjoying your new machine. Unfortunately, without more information, I can't help you track down manuals for it. The Boulder phone book doesn't list any business under the name Tech Center, and I ended up speaking with several people who work for

companies with similar-sounding names (thanks to all who helped!). If that's the correct and full company name, perhaps it's out of business now.

I'm more concerned about the name on your computer. No one seems to have heard of a computer built under the name Arch Tech. Perhaps your machine is from Arche Technologies? In that case, you can reach Arche at 48881 Kato Rd., Fremont, CA 94539, (415) 623-8100. Be specific with the exact configuration and model numbers of your system components. I'm reasonably convinced that your experience was simply the result of bad communication, not because you're a foreigner. Companies that do business that way simply don't stay around very long.—H. E.

More on Fractint

A number of years ago, I obtained a disk displaying Mandelbrot fractals from BYTE. Now I have obtained Fractint version 12.0, but I have a problem.

I have an Olivetti M24 computer that I understand is equivalent to an AT&T 6300 computer. Mine is fitted with CGA and a color monitor. The computer has been upgraded using Sota 286i and is also fitted with an 80287 math coprocessor.

My problem: Using Fractint, I get only four colors. With WordStar, Turbo Pascal, Paradox, Quattro Pro, and GW-BASIC, I can obtain all the colors I desire on the screen.

By the way, I am having the same problem using Flight Simulator 3, but not using the American version of Tetris. I have been a subscriber to BYTE for the last four years, and I have become aware of your sympathetic approach to reader problems.

J. Yodaiken
Cape Town, South Africa

Unfortunately, CGA graphics capability hits its peak at four colors. The other applications that you mention are text-mode programs and provide more colors by using characters to make up the screens. Quattro Pro will also run in graphics mode, but it will then give you the same four-color limitation.

I am not familiar with the Tetris program that you mention, but again, I suspect it is a text-mode application. Obviously, text mode is not appropriate for detail-intensive programs like Fractint and Flight Simulator.

If you spend any time at all running graphics software, you may want to look into upgrading to a VGA system; the difference will be startling.—S. A.

I Just See Stars

I recently bought a new machine, and I was a bit dismayed to find my spreadsheet files full of stars when I tried to use them. All the labels were there intact, but no numbers. It didn't take too long to figure out the cause; I had to deal with similar problems on my old machine as well. The software thinks the machine has a numeric coprocessor, but it doesn't, so all the numbers are garbage.

Most software packages with the capability to use a coprocessor run a short routine at start-up that asks the coprocessor to store the control word (`FSTCW`) or the status word (`FSTSW`) into memory. If this works (i.e., if the value in the memory location is changed or is a valid value), then the software assumes you have a coprocessor and uses it thereafter to do numeric operations.

Both the machines that I have owned will return values when asked to do one or other of the above operations, and I know several other people who have run into this type of problem. Where does the fault lie?

Why do software companies include such flimsy and potentially fallible checks for the 80x87 in their software and compilers? I started getting weird numbers in my spreadsheets one time because the 80287 was half out of its socket after I'd been messing around putting in a board. It still passed the check for presence, even though half the pins were not connected. Why doesn't the routine check the results of a division or a multiplication?

Jon Waterhouse
St. John's, Newfoundland, Canada

If your spreadsheet software (whose name you fail to mention) checks for a coprocessor in the way you describe, then you're right to feel dismayed. Most software will look for a coprocessor via the BIOS equipment check interrupt (11 hexadecimal). This interrupt returns a word full of flags that is set by your machine's power-on self test routines. How the POST routine does its job probably varies from BIOS to BIOS. Some machines require you to install a jumper whenever you install a coprocessor, and in that case the BIOS may simply look for the presence of that jumper. Also, AT-class machines expect a flag set in the nonvolatile CMOS RAM indicating the presence of a coprocessor. Have you checked your machine for either of these possibilities?

Finally, if you want to know how software can detect and identify an 80x87 coprocessor, look for BYTE's March 1988 issue. Prakash Chandra of Intel shows assembly language source code in his article "Programming the 80387 Coprocessor."—R. G.

PostScript Preview

I'm trying to find a PC program that will let you preview, one page at a time, the contents of a text file as it would appear when printed on a LaserWriter Plus.

This program would be used by students of the Chisolm Institute of Technology to print their assignments. At present, we have a program that converts files from various word processing programs to PostScript. This transformed file is then sent to the LaserWriter Plus for printing.

There is a shortcoming with this arrangement. After you've committed the text file to laser printing, there is no turning back. Consequently, students can lose a lot of money on wasted printing.

Graham Brown
Dromana, Victoria, Australia

Most word processing programs these days will support PostScript. You should call the vendors of the various word processing programs and ask for a PostScript driver. At the same time, ask if the program has a preview mode. Many word processors will either show you what the printed output will look like on-screen or will print the output to a disk file. As long as you have a PostScript driver installed, the preview should look exactly like the final printed output. If you can find drivers, this would be your best bet.

Another solution is a PostScript interpreter. The primary purpose of a PostScript interpreter is to convert PostScript files so that they can be printed on non-PostScript printers. Although you would not need one for this purpose, a PostScript interpreter might include a preview mode as well, so you could use such a program to see how the final printed page will appear. LaserGo (9369 Carroll Park Dr., Suite A, San Diego, CA 92121, 800-955-3668) should be able to help you. The company's GoScript program will display PostScript on EGA or VGA monitors. It will also display TIF and PCX files.—S. D.

FIXES

In "Faster Gets Smaller" (August), Compaq inadvertently provided BYTE with the wrong FCC rating for the Deskpro 386/25e. The correct rating is FCC Class B, not Class A. ■

Here's what they say about Zortech C++

" Zortech is a truly fine compiler...If you've been waiting for a major player to offer a professional C++ development system for OS/2 and Windows, as well as DOS, wait no longer... Zortech has it! "

Richard Hale Shaw, PC Magazine, p.38, March 13, 1990

"' Zortech has done a commendable job with C++ 2.0 and I recommend it highly...The debugger is impressive...Get the Developers version...it's worth the money."

Bruce Eckel, Micro Cornucopia, pp. 8-17, March 1990

" Zortech C++ is one of the best MS-DOS products I've had the luck to use.....I can highly recommend the Zortech 2.0 release."

Scott Robert Ladd, Dr. Dobbs Journal, pp. 64-73, January 1990

"We have devoted virtually a full issue to evaluation of C Compilers. . . . it's an easy choice. We pick ZORTECH."

J. D. Hilderbrand, Editor, Computer Language, p. 7, May 1990

AT&T™C++ V2 Specification
- ✓ Multiple Inheritance
- ✓ Type Safe Linkage
- ✓ Pointers to Members

Compiler Features
- ✓ Native code compiler with separate global optimzer
- ✓ Improved MSC Source Level Compatibility
- ✓ MS Windows™ Compatible
- ✓ CodeView™ Compatible
- ✓ Fast Graphics Library with C++ interface
- ✓ Easy to use TSR functions
- ✓ Standard Library Source Code included with Developer's Edition
- ✓ Seamless LIM/EMS Support via new handle pointers or directly via EMS library functions.
- ✓ Full MS Mouse Library
- ✓ OS/2 Compiler Option
- ✓ 99% ANSI C Compatible
- ✓ Improved code size/speed

C++ Source Level Debugger
- ✓ Also Debugs C
- ✓ Assembler Debugging with access to registers and memory.
- ✓ 16 Debugging Windows
- ✓ Multiple Statement Lines
- ✓ Break/Trace/Watchpoints
- ✓ Dual Monitor Support
- ✓ Full C++ name unmangling for easy use
- ✓ Block memory write protect

C++ Tools Classes
- ✓ 25 C++ Classes with full source code
- ✓ Includes new Text User Interface Classes
- ✓ Event Queue, BCD Maths, Linked Lists, Money, DOS error handling classes, text windows and editing classes, virtual arrays, time and date handling, directories and filenames, interupt vectors, etc...

PRICES

C++ Compiler	$199.95
C++ Debugger	$149.95
C++ Tools	$149.95
Library Source	$149.95

Save $200 - Get the Developer's Edition for only $450 (includes all the above items).

OS/2 Option	$149.95
C++ Video	$499.95

USA: Zortech Inc.
4-C Gill Street
WOBURN MA01801
Voice: 617-937-0696
Fax: 617-937-0793

EUROPE: Zortech Ltd.
106-108 Powis Street
LONDON SE18 6LU
Voice: 44+ 81-316-7777
Fax: 44+ 81-316-4138

"ANNOUNCING V2.1"

640K Memory Barrier Smashed!

- **New** VCM™ (Virtual Code Manager) technology
- **New** Rational DOS Extender technology for compiling/ debugging massive programs
- **New** Virtual C++ Source Level Debugger requires only 4k RAM!
- **New** Remote Debugging via serial port
- **New** Powerful Environment with Browser
- **New** Completely Revised & Expanded C++ Tools
- **New** Improved Compiler Optimization

Zortech VCM™ for DOS

With Zortech's Virtual Code Manager (VCM) you can compile standard MS-DOS applications containing up to 4Mb of code. VCM is a sophisticated virtual memory system that dramatically improves performance over conventional overlay methods. Naturally, our debugger understands VCM too!

Rational™ DOS Extender Technology...

Version 2.1 incorporates this new technology for compiling and debugging really big programs on 286, 386 or 486 based PC's. You can also use V2.1 together with Rational Systems DOS Extender (purchased separately) to produce your own applications which can access memory beyond the 640k DOS limit.

C++ Debugger in 4k RAM!

Zortech's Virtual C++ Source Level Debugger can now locate itself in extended memory on 386 machines. This requires only 4K of conventional RAM!

STOP PRESS - NEWS FLASH

386 Compiler/Debugger Option (using Phar Lapp DOS Extender), UNIX 386 Compiler and OS/2 Debugger all available soon. Also new C++ Classes and Addison Wesley ZTC++ book.

ORDER/UPGRADE HOTLINE 1-800-848-8408

386SX Multi-Task Force

Launch and run two, three, four or more programs simultaneously. Blast the 640K memory barrier to cut even the most massive programs down to size. And, rocket through spreadsheets, word processing, desktop publishing and more with lightning-fast 16MHz, 32-bit speed. With this new BSR 386SX computer and your FREE bonus Microsoft Windows 3.0, you'll infuse your computing with the time- and work-annihilating might of true multi-tasking and 386SX power. PLUS, you get $2,850 worth of FREE NAME-BRAND software. Plus, as an added Super Bonus, you also get $495 Quattro Pro. You'll be armed and ready to assault any business, learning and creative project, all for DAK's industry-busting price of just $1,799.

By Drew Kaplan

Get ready to unleash breakthrough computing power. Imagine writing a sales report with your word processor while simultaneously recalculating a spreadsheet.

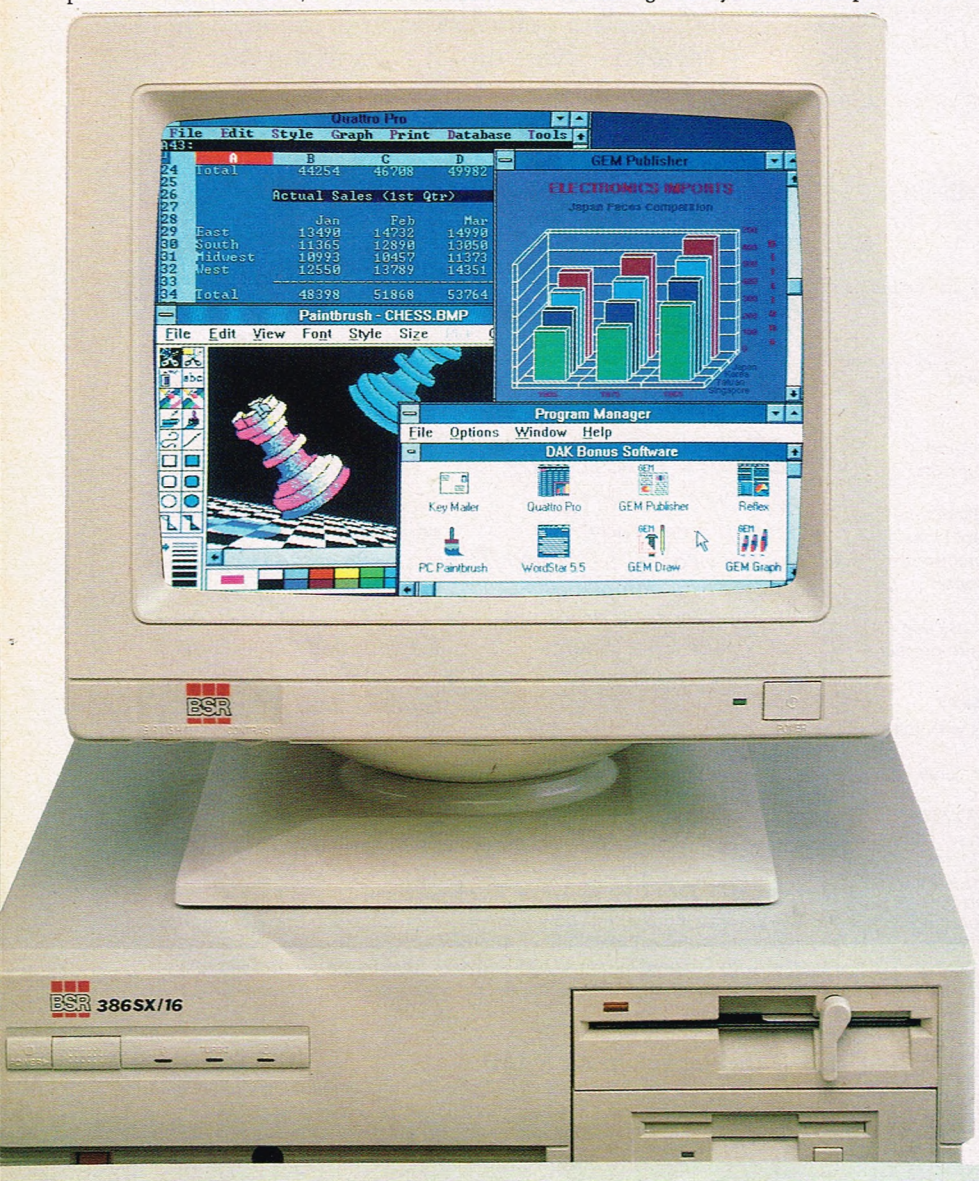
Imagine running massive desktop publishing programs with plenty of RAM to spare. And, imagine blazing through all your computer work with lightning-fast 16MHz 32-bit speed all for just $1,799.

Sound like a fantasy? With most computers it would be. But, not with this new BSR 16MHz 386SX Computer with 1 full megabyte of RAM, massive 28 millisecond hard drive and .31 dot pitch VGA monitor.

It's the most powerful, fully-loaded computer DAK has ever offered.

Plus, with the included Microsoft Windows 3.0 and $2,850 worth of additional FREE bonus software (including WordStar 5.5), you'll be armed to make short work of any computer project.

Read on and together we'll explore all the amazing feats you'll accomplish with this work-vanquishing, time-saving, productivity-enhancing 386SX computer.



ANATOMY OF A 386SX

At the heart of this new BSR 386SX computer is the latest 386SX microprocessor.

Unlike a 286 microprocessor (found in AT computers), which processes information in 16-bit chunks, a 386SX can process information in 32-bit chunks. So, it can handle more than twice the information a standard 286 can, in less time. Wow!

Plus, you'll be able to run the latest 386 programs and all PC/AT compatible programs.

This 16MHz, 0-wait state speed demon can calculate spreadsheets, reformat desktop publishing documents and run any of the FREE programs in record time.

But, if you're like me, you use your computer mostly for word processing. So you might not be too concerned with speed. I wasn't either, until I pitted my old 286 against the BSR 386SX.

I spell-checked the same 50-page report on both computers. I was astounded to discover that the 386SX spell-checked the document over a minute faster.

A single minute may not seem like much, but when you think of how many reports, letters and proposals you spell-check in one week, those minutes add up.

Plus, just wait till you see how quickly this 386SX boots up, and how fast you'll run through complex spreadsheets like Quattro Pro. But, speed is just one small part of the sheer might of this fantastic 386SX.

INCLUDED BONUS SOFTWARE

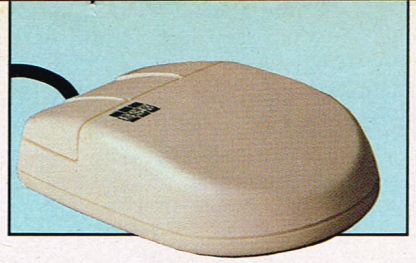
	Retail Price
Microsoft Windows 3.0	$149
Quattro Pro	$495
WordStar 5.5 Professional	$495
Reflex 2.0	$249
Gem Desktop Publisher	$299
Gem Graph	$299
Gem Draw Plus	$299
Gem WordChart	$199
SideKick	$ 89
Key FormDesigner	$179
KeyMailer	$149
Three-Button Mouse	$ 99
Grammatik IV	$ 99
PC Paintbrush	$ 99
PC USA	$ 69
Keyboard/Keypad Trainer	$ 69
KeyDictionary	$ 99
WordFinder	$ 59

It's $3,494 worth of BONUS software included with your BSR 386SX computer!

DOWNTIME DECIMATOR

The true power of this BSR 386SX is its astounding memory handling capability. It shatters the 640K RAM barrier which shackles 286 computers.

No longer will you be limited to the old DOS standard of 640K RAM. Sure, some 286



With your FREE included three-button mouse you'll zoom through databases, desktop publishing and word processing at meteoric speed.

computers have 1 meg or more of RAM. But, most programs don't actually use it.

But, with your 386SX and a memory-managing program like the incredible **Microsoft Windows 3.0,** (yours absolutely FREE), you'll use all of this computer's 1 full meg of RAM (or 2 full megs with optional upgrade for just **$79.90**).

Now you can run high-performance business spreadsheets, (like your just-released **Quattro Pro bonus**), huge databases (such as **Reflex 2.0**) and desktop publishers (like the included **GEM Desktop Publisher,** complete with **Gem Graph, Gem Draw Plus** and **Gem WordChart**) with ease.

And, look at this. With your 386SX and **Microsoft Windows 3.0**, you'll be able to multi-task. That means you can run several programs simultaneously and transfer information between most programs.

For example, you can work on a sales report with the included WordStar 5.5 and then instantly pull up Quattro Pro to double check your sales figures **without exiting WordStar. It's a real time-saver.**

You can even 'cut' figures directly from Quattro Pro and automatically 'paste' them into your report, on-screen.

And, wait till you discover multi-tasking. With Microsoft Windows 3.0 this 386SX computer can do the work of several ordinary computers, concurrently.

Forget having your computer tied up while it recalculates a spreadsheet or formats and prints out a complex desktop publishing document. Your 386SX obliterates downtime forever.

THE COMPUTER OF THE FUTURE

The experts like *PC Magazine* and *Infoworld* agree that the 386 is the future standard. And, most of the new programs developed over the next few years will be created for 386-compatible computers.

So, with your BSR 386SX you'll already by prepared for the future of computing with full 386 compatibility. Plus, you'll have complete 286 compatibility too.

LOADED WITH COMPUTING POWER

This awesome computer comes fully-armed with an arsenal of work-annihilating features. With other computer companies, most of these features are optional. But, they're all standard on your 386SX.

14" VGA Monitor (Standard). With its phenomenal 640 X 480 (.31 dot pitch), slide-like resolution, this easy-on-the-eyes, non-glare 14" color VGA monitor is the most brilliant I've ever seen.

Plus, just wait till you see how the palette of 256,000 colors can make all your graphs, charts, paintings and even word processing and spreadsheets explode off the screen with sharp, vivid power.

And, with the included tilt swivel monitor base, you can easily adjust the monitor to the perfect viewing angle for you.

40-Megabyte Hard Drive (Standard). The powerbase behind your work-vanquishing 386SX is a mammoth super-fast, 28-millisecond, 16-bit, 40-megabyte hard drive.

You'll have the informational storage power of over 110 traditional floppy disks to save all of your creations and programs with plenty of room to spare.

And, if you're running a company or need all the storage space you can get, you can upgrade to a colossal 80-megabyte hard drive for just **$199.90**.

1 Full Megabyte of RAM (Standard). You'll have plenty of power to run even the most massive memory-devouring programs with the included 1 megabyte of high-speed RAM (expandable to up to 8 megabytes on the motherboard), complete with LIM 4.0 emulation capability.

And, you can upgrade to 2 megabytes of RAM for virtually unlimited multi-tasking power for just **$79.90**.

Both 5¼" AND 3½" Floppy Drives (Standard). You get two floppy drives with your BSR 386SX computer.

First, there's a 1.2MB, high-density 5¼" floppy disk drive. You can store nearly 4 times more information on a 1.2MB floppy than you can on a standard 360K floppy.

And, you can still use and exchange 360K floppies with less sophisticated computer users than yourself.

Plus, there's also a 1.44MB high-density 3½" floppy disk drive, so you can easily switch floppies between your 386SX and the latest IBM computers and even 1.44MB and 720K laptop computers.

4 Expansion Slots. With its 4 expansion slots (3 available), your 386SX is engineered to grow with your computing needs.

You'll have plenty of room to add a fax card, a scanner card or a voice-mail card.

NOTE: This computer's advanced 386 motherboard requires only a cool-running 145 watt power supply, so you'll have plenty of power for expansion cards.

Serial, Parallel and Mouse Ports (Standard). You'll have two serial ports to use with serial devices. You get a parallel port for printer hook-up.

And, there's a mouse port for your included 3-button bus mouse (more later).

101-Key Extended Keyboard (Standard). Virtually all interaction with your computer is through the keyboard. That's why this breakthrough computer comes with the newest extended keyboard complete with separate arrow/cursor keys.

You'll never have to hunt through the number keys to find the cursor keys again.

Plus, the solid feel of the sculptured keys ends finger fatigue forever. Whether you 'hunt & peck' or type 90 words-per-minute, you'll really appreciate the tactile feedback of this high-quality keyboard.

MS DOS 3.31 and GW-Basic (Standard). It amazes me how many retailers sell computers without DOS and Basic. At DAK, you get everything to have your computer up and running right away.

Special Note: DOS 3.31 breaks the 32 meg hard disk size limitation, so you can use your 40 meg (or optional 80 meg) hard drive without cumbersome partitions.

Clock/Calendar with Battery Back-Up and More. Plus, this extraordinary computer has a clock/calendar with battery back-up, a front panel reset switch and 80387 math co-processor socket, 8MHz/16MHz switching and dozens more features.

ON-SITE SERVICE

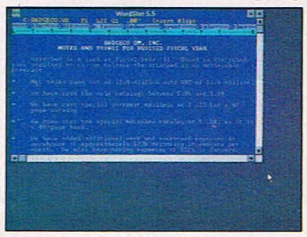
With a lot of companies, once you buy a computer, you're on your own. If you're lucky, they'll give you a 90-day warranty.

But, your BSR 386SX computer is backed by a 12-month, **on-site** standard limited warranty. You'll receive in-home or in-office service anywhere in the continental United States. You're totally protected.

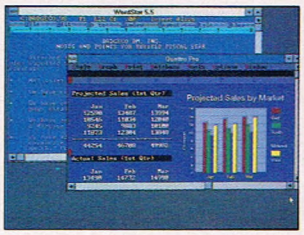
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Multi-Tasking Explained

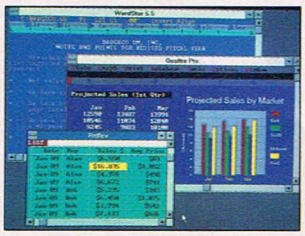
It's called multi-tasking. And, it's revolutionizing the way we work with computers. What 'multi-tasking' means is you can run several programs at the same time. For example, you can have a spreadsheet program like Quattro Pro run calculations while you use a word processor like WordStar 5.5 to write a letter or report. Plus, you can 'pull-up' other programs WITHOUT exiting the program you're working in. It's a real time-saver if you switch programs a lot. Here's just one example of how you can use multi-tasking to blast through your work.



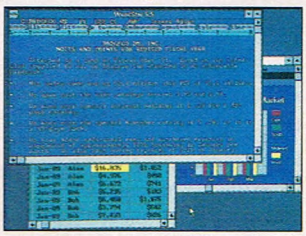
1. Let's say you're the sales manager for a company or you own your own business. You're writing a report with WordStar 5.5. As you work, you decide to double-check some figures in your Quattro Pro spreadsheet.



2. Without exiting WordStar, you pull up Quattro Pro in another window. Now you can check your spreadsheet and even cut figures from Quattro Pro and paste them directly into your WordStar report.



3. Next, you decide to check the performance of your sales people. Without exiting WordStar or Quattro Pro, you pull up Reflex 2.0 in a third window. Now you can easily scroll through your sales database.



4. After you've confirmed all your figures, (and cut and pasted just the ones you need into your report), with a click of your mouse, you pull the WordStar window to the front of the screen and finish writing your report.

. . . 386SX Multi-Task Continued)

Plus, you get DAK's own toll-free software support lines, manned with helpful, knowledgeable DAKonians ready to answer all of your software questions.

WHY BSR?

DAKonians know about BSR through their audiophile stereo equipment. But, what most people don't know is that BSR was one of the world's leading manufacturers of computer power supplies.

And, this new BSR 386SX follows in that same industry-leading tradition. Plus, because of DAK's direct-from-the-factory purchase, I got a fantastic price.

Now you can command all the computing muscle of a fully-loaded 386SX for less than the price of many 286 computers.

And, let's not forget your Super Bonus $495 Quattro Pro. Plus, Microsoft Windows 3.0 and the $2,850 worth of brand-name computer software (including WordStar 5.5, Gem Publisher, Key FormDesigner and more) you get absolutely FREE.

COMMAND A 386SX MULTI-TASK FORCE RISK FREE

Wait till you experience the blinding speed of 16Mhz, 32-bit computing. Wait till you cut and paste information between two different programs with ease. And, wait till you work on two, three, four or even more programs concurrently.

If you're not completely thrilled simply return it to DAK in its original box within 30 days for a courteous refund.

To order Your Work Annihilating 16MHz, 32-Bit 386SX Multi-Task Force complete with Massive 40-Megabyte, Super-Fast 28-Millisecond, 16-Bit Hard Drive, 1 Full Meg of RAM (upgradable to 8 Megs), 1.2 Megabyte 5¼" Floppy Drive, 1.44 Megabyte 3½" Disk Drive, 14" Slide-Like .31 Dot Pitch Color VGA Monitor with Tilt Swivel Base, Advanced DOS 3.31 and GW-Basic, PLUS Microsoft Windows 3.0, PLUS $495 Quattro Pro, PLUS $2,850 worth of the Name Brand Software Bonuses AND 12-Month On-Site Service Warranty, call toll free or send your check for DAK's industry-busting price of just **$1,799** ($69 P&H). Order No. 6335. CA res add tax.

———— Options ————

RAM BREAKTHROUGH OPTION

Turbo-charge your 386SX with even more multi-tasking power by upgrading to a full 2-megabytes RAM for just **$79⁹⁰** ($0 P&H). Order No. 6336. **Note: The RAM upgrade must be ordered with your computer.**

80-MEGABYTE HARD DRIVE OPTION

Now you can have an enormous 80 megabytes of hard disk space to store all your work and programs for just **$199⁹⁰** ($0 P&H). Order No. 6337. **Note: The hard disk upgrade must be ordered with your computer.**

You'll command the power to run two, three, four or even more programs concurrently. And, with the $3,494 worth of included name-brand software you'll be armed and ready to vanquish any computing task. ☒



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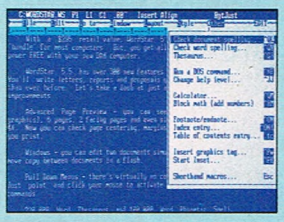
For Toll Free Information, Call 6AM-5PM Monday-Friday PST
Technical Information 1-800-888-9818
Any Other Inquiries 1-800-888-7808
8200 Remmet Ave., Canoga Park, CA 91304

Just Look

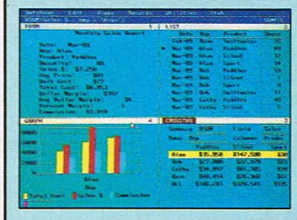
Here's a preview of just a few of the name-brand software programs included with your BSR 386SX computer.



Quattro Pro combines BIG corporation spreadsheet power with vivid graphics. You can analyze, forecast and print out your data in numbers and 3-D charts.



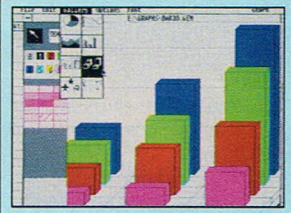
WordStar 5.5 has over 300 work-saving enhancements, including easy-to-use Pull-Down Menus that obliterate keyboard commands.



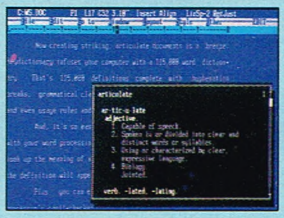
With Reflex 2.0 database, you can organize, analyze and even display your crucial business data in 6 different ways including Form, List, Graph and Crosstab views.



You can easily create reports, proposals, newsletters and more with charts, drawings, graphs and multiple font styles with the Gem Desktop Publishing System.



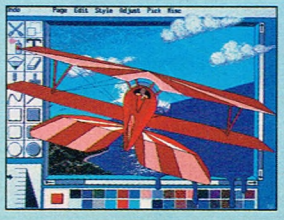
Gem Graph's vivid 3-D bar graphs, pie charts, symbol graphs and line charts will infuse your reports, proposals and presentations with explosive visual power.



With the touch of a hotkey, KeyDictionary, with 115,000 on-line, full definitions, gives you instant answers to questions about word meanings, spelling, usage and hyphenation.



KeyMailer's fill-in-the-blank format is the easy way to create extensive mailing-list data bases and thousands of personalized letters complete with address labels.



It's a cinch to illustrate any graphic from a professional organization chart to a Mojave Desert Sunset with PC Paintbrush's icons and pull-down menus.

Let's take a quick look at the $3,494 worth of name-brand software programs included with your BSR 386SX computer.

SUPER BONUS Quattro Pro ($495 Value)

Now all of us small businessmen can take advantage of BIG corporation spreadsheet power without needing a degree in accounting.

Top-rated Quattro Pro can effortlessly lay out a financial strategy for you. And, you'll see it in numbers, dollars and 3-D graphs on-screen or printed out.

Plus, Quattro Pro's new VROOMM (Virtual Realtime Object-Oriented Memory Manager) reads and writes even the largest Lotus files without translation.

FREE BONUS #1 Microsoft Windows 3.0 ($149 Value)

We've already explored the incredible memory managing, multi-tasking, and 'cut & paste' abilities of Windows 3.0. But it can do so much more.

It obliterates complex DOS commands with an easy-to-use icon-based environment. You can launch any installed DOS or Windows-based program merely by double-clicking your included mouse on an icon. It's a real time-saver.

Plus, you also get a file manager, a print manager and much more to help you finish all your computer work easier, faster and better than ever before possible.

FREE BONUS #2 WordStar 5.5 ($495 Value)

WordStar 5.5 has over 300 new features and enhancements to make writing powerful letters, reports and proposals a breeze.

The instant you fire-up WordStar, you can type a letter, add bold, italics and underline. It's easy with the Pull-Down Menus.

With Editing Windows, you can edit two documents simultaneously. You can even copy and move text between them.

Plus, you can view up to 32 pages at once with the Advanced Page Preview. So, you can check page centering, margins and layout **before you print.**

FREE BONUS #3 Reflex 2.0 ($249 Value)

It's the easiest and most powerful flat-file database I've ever used. Now you can store and organize all your critical business, club or personal data quickly and easily.

Plus, top-rated Reflex can also turn your raw data into attention-grabbing pie, line bar and scatter graphs that instantly give you the meanings behind the numbers.

And, you can instantly cut and paste information from Reflex directly into your word processor or spreadsheet. Reflex is a quick and easy way to compare, summarize and analyze all your vital data.

FREE BONUS #4 Key FormDesigner ($179 Value)

Create any type of form from simple personalized appointment book pages to complex inventory control forms. Imagine easily designing purchase orders, employment applications, ledger sheets and more.

With Key FormDesigner, you can custom-tailor forms to your EXACT needs. In minutes, you can produce new, more efficient forms for the whole company, for your department, or just for you.

And, you can print out your customized forms on any dot-matrix, ink jet or laser printer. Best of all, you'll never need to wait

At All You Get FREE

weeks or pay for custom forms again.

FREE BONUS #5 Sidekick ($89 Value)

Sidekick is a powerful desktop organizer that puts 4 essential business tools right at your fingertips. You get an electronic notepad so you can take down notes easily.

There's an on-line, pop-up calculator and a perpetual calendar/appointment scheduler, too. Plus, with Sidekick's phone book, you can store all your frequently called modem numbers in an on-line directory that dials the numbers for you.

FREE BONUS #6 Gem Desktop Publisher ($299 Value)

Now you can create spectacular brochures, multi-columned newsletters, graphic-packed manuals, mind-grabbing reports and even your own magazines right at your desk.

With just the click of a mouse, you'll insert maps, diagrams, schematics, artwork, logos and graphs into any document. And, you'll compose eye-catching professional reports, articles and academic papers.

FREE BONUS #7 Gem Graph ($299 Value)

Now you can easily create dazzling reports, proposals and brochures filled with attention-grabbing 3-D graphs and charts.

Wait till you see all the two and even three dimensional bar graphs, pie charts, and comparative line charts that jump off the page with sit-up-and-take-notice power.

You can choose from a huge selection of graph and text styles (including striking 3-D), to add that extra amount of punch to really drive your point home.

FREE BONUS #8 Gem WordChart ($199 Value)

What Gem Graph does with numbers, Gem WordChart does with words. Create extensive fact tables for sales reports.

Make bullet charts to add graphic impact to your presentations and proposals. And, even make eye-grabbing sale fliers for your business that will have customers streaming in. It's a cinch to create everything from party invitations to menus.

FREE BONUS #9 Gem Draw Plus ($299 Value)

You can effortlessly design anything from simple floor plans to complicated electrical schematics. Create graphics for club newsletters. And, you can even draw flow charts and organizational charts with ease.

There's also a full library of pre-drawn clip art that you can insert directly into your documents. Plus, Gem Draw Plus is object-oriented. So, for example, if you overlay a circle with a square, they mix on the screen but are kept separate in the memory.

Gem Draw Plus is the easy way to transform your ideas into vivid drawings.

FREE BONUS #10 PC USA ($69 Value)

You'll command a wealth of vivid graphics and fact-filled tables packed with current and historical information on all the 50 states and even Puerto Rico.

You'll have instant access to beautifully detailed state maps showing elevations, cities and geographical features. You'll easily pinpoint distances between cities.

And, you'll effortlessly access statistics on population and age distribution, health, crime, tourist attractions, climate trends, taxes, state histories and much more—all with a touch of a button.

FREE BONUS #11 KeyMailer ($ 149 Value)

With KeyMailer's menu-driven, fill-in-the-blank format, anyone can create an extensive mailing-list database.

Now you can print out envelope labels, telephone directories and even merge your data with WordStar to effortlessly make and send 100, 1,000 or even 10,000 personalized letters for your business or club.

FREE BONUS #12 Keyboard/Keypad Trainer ($69 Value)

Here's an easy way to increase your typing speed and finish your work 25%, 50% or even 100% faster.

This amazing breakthrough program uses Artificial Intelligence (AI) to tailor exercises to your learning needs. Plus, you'll have customized AI lessons for your computer's numeric keypad, too.

FREE BONUS #13 Grammatik IV ($99 Value)

Grammatik IV uses 42 grammar rules to automatically check all your reports, essays and everything you write.

You'll never worry about incomplete sentences, punctuation errors or using 'it's' instead of 'its,' 'they're instead of 'their,' or 'two' instead of 'too.' Grammatik IV never changes your writing. Whether you use its advice or not is completely up to you.

FREE BONUS #14 KeyDictionary ($99 Value)

With 115,000 full, on-line definitions complete with hyphenation and usage rules, this awesome electronic dictionary makes writing captivating documents a breeze.

You can instantly define words, in or out of word processing, with just the touch of a hot key. Plus, you can even define words within definitions and spell-checker and thesaurus suggestions.

FREE BONUS #15 WordFinder ($59 Value)

Infuse (penetrate, instill, inject) the power of WordFinder's instant-access 220,000-word Thesaurus into your reports, proposals and contracts. It's great.

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FREE BONUS # 16 PC Paintbrush ($99 Value)

With PC Paintbrush, you'll unleash your creativity with computer-generated shapes, designs, patterns and drawings.

You'll have 5 different brush shapes, a paint roller, computerized air brush, and a palette of up to 16 colors to create and print-out everything from breathtaking landscapes to company logos.

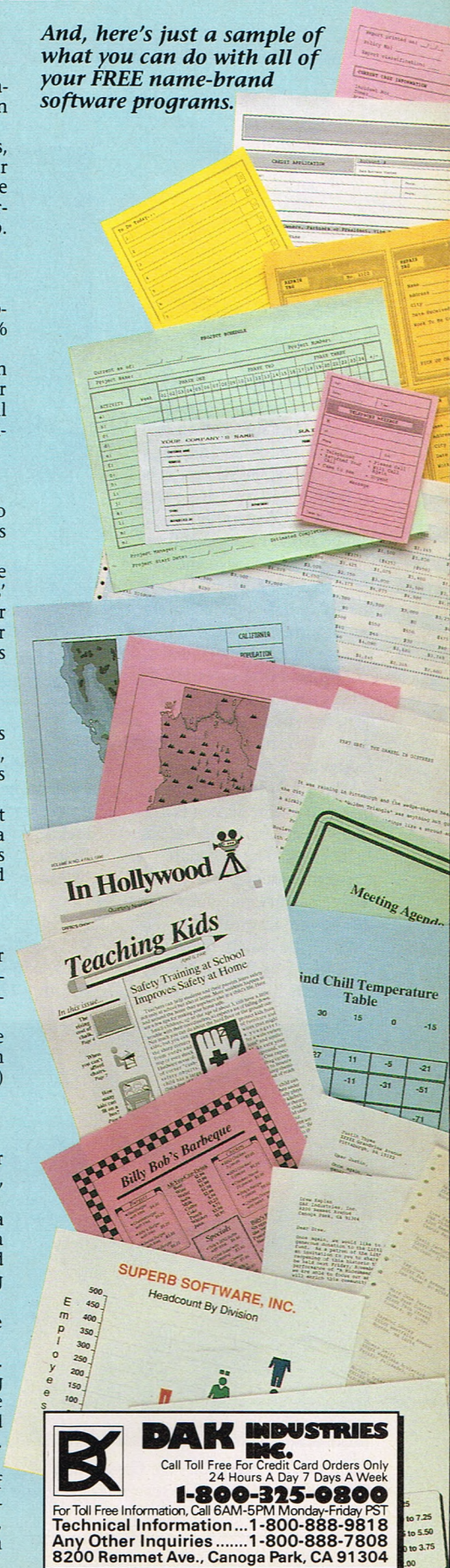
FREE BONUS #17 Three-Button Mouse ($99 Value)

Obliterate clumsy keyboard commands. From drawing and painting to accessing menus and windows to controlling the cursor, you'll do it all infinitely easier and faster with the new BSR 3-button bus mouse.

$3,494 Of Software FREE

You get it all, a total of $3,494 worth of software and hardware (including Microsoft Windows 3.0, PLUS $495 Quattro Pro), PLUS the BSR 16Mhz 386SX Computer with VGA monitor for just $1,799.

And, here's just a sample of what you can do with all of your FREE name-brand software programs.

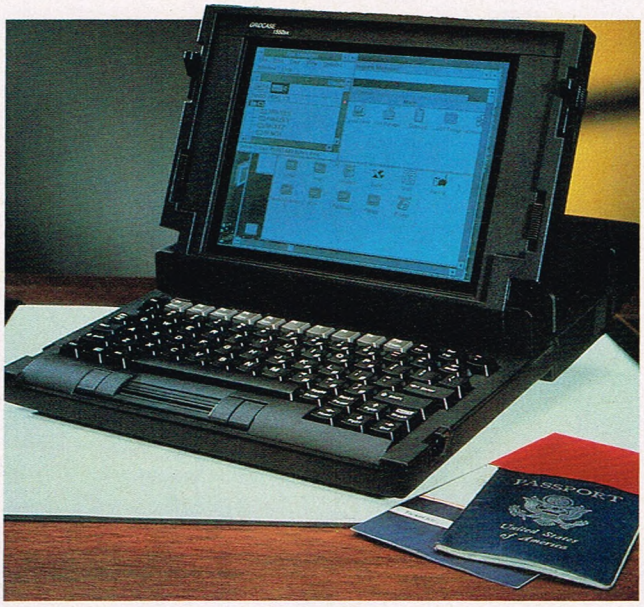


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The 1550sx is the latest in GRiD's line of laptops. This one features the rolling Isopoint device shown here.

Isopoint Device Makes a Case for GRiD

The GRiDCase 1550sx is the first PC-compatible laptop to use the built-in Isopoint device. Also unique to the 20-MHz 386SX laptop is a 60-MB hard disk drive with Windows 3.0 installed.

The Isopoint device takes the place of a mouse and is built into the keyboard below the space bar. The Isopoint buttons are accessible to both right- and left-handed users.

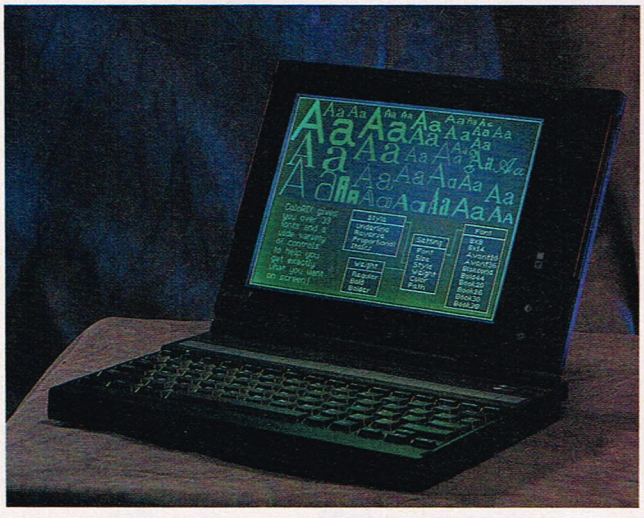
The hard disk drive has an access time of 16 ms and a 64K-byte memory cache. Also standard on the 12-pound laptop are 2 MB of RAM and a 3½-inch 1.44-MB floppy disk drive. The screen is a film-twisted-nematic backlit LCD VGA. The internal/external battery has a rated life of 2 hours and charges in 2½ hours, according to GRiD. The system measures 11½ by 15 by 2½ inches.

Options include a 120-MB hard disk drive, a 600-MB CD-ROM drive, a 2400-bps modem, an 80387SX math coprocessor, and an external rechargeable battery.

Price: Base system, $6295.

Contact: GRiD Systems Corp., 47211 Lakeview Blvd., P.O. Box 5003, Fremont, CA 94537, (800) 222-4743 or (415) 656-4700.

Inquiry 1290.



CompuAdd's notebook-size Companion weighs less than 5 pounds and has a VGA screen that displays up to 16 levels of gray scales.

Things Are Getting Small in Texas

The new Tandy 1500 HD, a notebook computer that weighs 6 pounds, comes standard with a 1.44-MB floppy disk drive and a 20-MB hard disk drive for less than $2000.

The 1500 HD, which measures 10 by 12⅕ by 1 7/10 inches, has a backlit screen, a 10-MHz NEC V-20 processor, and 640K bytes of RAM (expandable to 1.64 MB). The system also comes with DOS 3.3 and Tandy's DeskMate graphical user interface installed on the hard disk drive.

The blue-on-white LCD screen provides a resolution of 640 by 200 pixels (CGA). The removable nickel-cadmium battery weighs ¾ pound and recharges in as little as 4 hours, according to Tandy. An AC adapter is also included with the 1500 HD.

Price: $1999.

Contact: Tandy Corp., 1800 One Tandy Center, Fort Worth, TX 76102, (817) 390-3011.

Inquiry 1291.

The CompuAdd Companion, which measures 8½ by 11 by 1⅘ inches, has a 12-MHz 286 processor with 1 MB of RAM (expandable to 3 MB), a 20-MB hard disk drive, and a backlit VGA screen that measures 8 by 6 inches and displays 16 gray scales.

LapLink software is installed in ROM, as well as DOS 4.01 and diagnostics. The system also has an 80287 math coprocessor socket. A rechargeable battery pack and an AC adapter are included.

Price: $2895.

Contact: CompuAdd Corp., 12303 Technology Blvd., Austin, TX 78727, (800) 627-1967 or (512) 250-1489.

Inquiry 1292.

The Peregrine SX Has Landed

The Peregrine 20/32cSX is a 20-MHz 386SX with 2 MB of RAM, a 1024- by 768-pixel Super VGA display, a choice of floppy disk drives, a Microsoft Mouse, Windows 3.0, and DOS 4.01.

Hard disk drives are available in 40-, 80-, 105-, or 200-MB configurations, and the system will support an 80387SX math coprocessor.

Price: $1769; with 40-MB hard disk drive, $2159.

Contact: Peregrine Computers, 110 East Canal St., Troy, OH 45373, (800) 326-7015, ext. 3119 or (513) 339-3151.

Inquiry 1293.

24-wire Serial Printers in Wide and Narrow Versions

The MT130/24 and MT131/24 printers cost less than $1000 each and were tested to operate for over 7800 hours before failure, which is 30 percent longer than the nearest competitor, according to Mannesmann Tally.

The 24-wire serial printers operate at 300 cps in draft mode, 150 cps in near-letter-quality mode, 100 cps in letter-quality mode, and 12 cpi in all modes.

Paper-handling capabilities include single sheets, continuous forms, and four-part forms. The printers also have the ability to print single sheets without removal of continuous forms and to print continuous forms without removal of the optional sheet feeder.

Price: Narrow-carriage MT130/24, $899; wide-carriage MT131/24, $999.
Contact: Mannesmann Tally Corp., 8301 South 180th St., Kent, WA 98032, (206) 251-5500.
Inquiry 1294.

PostScript Laser Printer Crosses Bounds

NEC's Silentwriter2 Model 90 is a PostScript laser printer that is compatible with Macintosh and DOS environments and sells for less than $2500.

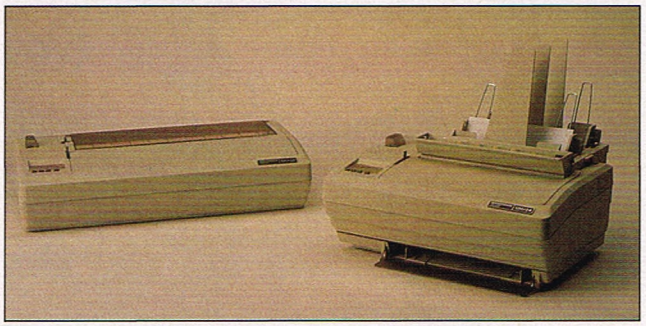
The 6-page-per-minute printer provides 2 MB of RAM (expandable to 4 MB). It has a Motorola 68000 processor with a built-in 16.7-MHz Adobe PostScript interpreter that provides 35 resident scalable typefaces. The printer also provides 13 resident fonts in Hewlett-Packard LaserJet IIP emulation.

The Silentwriter2 Model 90 prints at a resolution of 300 by 300 dpi. It weighs 44 pounds.

To hook it up to DOS or Mac systems, it comes with standard parallel, serial, and AppleTalk/RS-422 interfaces. It also comes with a software kit that shows you what the screen fonts will look like in printed documents. The software runs on Macs or under Windows in DOS environments.

A 250-sheet-capacity paper tray is included that holds up to 24-pound letter or legal-size paper, envelopes, or transparencies. The toner and optical photoconductor are in replaceable cartridges said to last for 6000 pages.

Price: $2495.
Contact: NEC Technologies, Inc., 1414 Massachusetts Ave., Boxborough, MA 01719, (508) 264-8000.
Inquiry 1295.



Mannesmann Tally offers low-cost wide- and narrow-carriage printers.

HSD Now Scanning the Mac Market

Like Scan-X for the NeXT machine, Scan-X Professional for the Macintosh features image-enhancement technology, which HSD Microcomputer calls Gray Spectrum Enhancement, that allows you to produce 256 shades of gray with superior quality, according to the company.

The Macintosh scanner supports resolutions of up to 1500 dpi for line art and 300 dpi for gray-scale images. It comes with Enhance software from MicroFrontier. The Enhance software offers 80 real-time filters, real-time gray-level manipulation and color painting, cropping, scaling from 25 percent to 800 percent, rotating, brushing, masking, text entry, processing, colorization, and ghosting.

Price: $1995.
Contact: HSD Microcomputer U.S., Inc., 1350 Pear Ave., Suite C, Mountain View, CA 94043, (415) 964-1400.
Inquiry 1296.

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Compact Bernoulli Drives

Iomega has announced its Universal family of Bernoulli removable disk subsystems. The family includes two portable Bernoulli subsystems: The Transportable is the smallest, lightest Bernoulli subsystem, according to Iomega; the Portable is a battery-powered version of the AC-powered Transportable.

All the subsystems in the Universal family work with the IBM PC, the Macintosh, and in networking environments. They all use the SCSI standard and also have optional interface kits available.

Price: Transportable, $1399; Portable, $1699.
Contact: Iomega Corp., 1821 West 4300 South, Roy, UT 84067, (800) 456-5522 or (801) 778-1000.
Inquiry 1297.

An IOcomm-Crafted Monitor

IOcomm, maker of the Wave keyboard, has introduced the CM-4210, a 14-inch Super VGA monitor. It features a .28 dot pitch and operates at 45 MHz with a resolution of 1024 by 768 pixels (interlaced). The monitor has a nonglare screen and meets worldwide safety regulations.

While the CM-4210 is not inexpensive, IOcomm says that it offers brighter colors, sharper details, and firmer picture stability than its competitors.

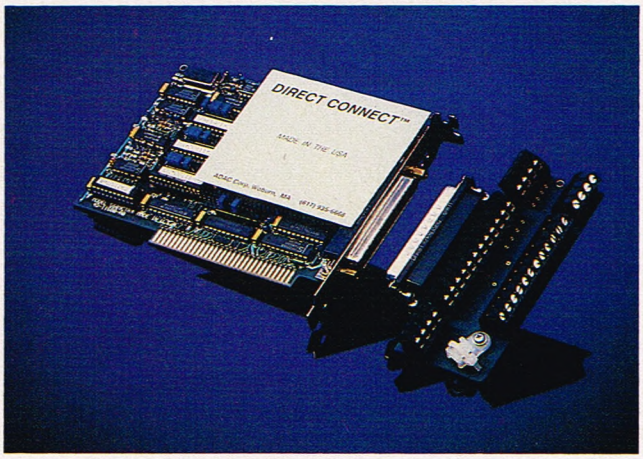
Price: $549.
Contact: IOcomm, 12700 Yukon Ave., Hawthorne, CA 90250, (213) 644-6100.
Inquiry 1298.

16-bit Data Acquisition

The 5508HR is a half-size analog input module for PCs and laptops that includes detachable screw terminations. The board has eight differential and 16 single-ended analog inputs and a choice of 15- or 50-kHz A/D throughputs.

The detachable-screw-termination design allows you to wire analog and digital signals directly to the rear of the computer, eliminating cabling and external screw-terminal panels. The board measures 3 9/10 by 6 inches.

Price: 15-kHz model, $895; 50-kHz model, $1295.
Contact: Adac Corp., 70 Tower Office Park, Woburn, MA 01801, (800) 648-6589 or (617) 935-6668.
Inquiry 1299.



Adac's Direct Connect 5508HR data acquisition board.

Rapid Prototyping with Protosystem AT

Protosystem AT is a wire-wrap prototype card for rapid prototyping of circuits for the IBM AT, according to Cana Group.

The manual wire-wrap card has pins soldered in place on every signal line, along with bypass capacitors on every power line. According to Cana, it holds more than 100 16-pin IC sockets.

For ease of use, the signal pins are never closer together than 1/5 inch. The signal lines are grouped onto address, data, and control buses. For quick troubleshooting, each signal pin has a label on each side of the board.

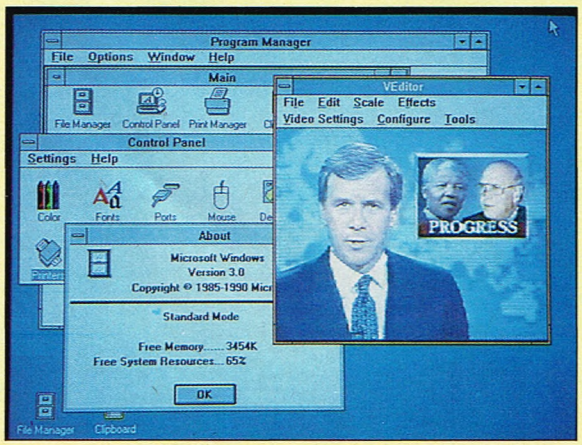
Price: $149.95.
Contact: Cana Group, Suite 402, 100 Walnut St., Peoria, IL 61602, (800) 747-2262 or (309) 674-9009.
Inquiry 1300.

Multimedia for Windows 3.0

VideoWindows digital video board comes with multimedia software that runs under Windows 3.0. The board and software combination lets you position windows of full-motion, full-color video anywhere on a VGA display, according to New Media Graphics. You can scale, reposition, crop, and zoom the video in real time. And image-capture capabilities are also included.

VideoWindows works with any NTSC or PAL video source, and you can overlay graphics on the video.

Price: $2390.
Contact: New Media Graphics Corp., 780 Boston Rd., Billerica, MA 01821, (508) 663-0666.
Inquiry 1303.



Shift Your LaserJet into High Gear

An expandable memory board for LaserJet IIP and III printers, the LaserGo Memory Board lets you add up to 4 MB with one board. You can install the board with just a screwdriver, according to LaserGo, and it automatically senses whether it's in a LaserJet IIP or III. The board, which comes with 1 MB, is expandable to 4 MB and is compatible with Hewlett-Packard memory boards already installed.

Price: $295.
Contact: LaserGo, Inc., 9369 Carroll Park Dr., Suite A, San Diego, CA 92121, (800) 955-1132 or (619) 450-4600.
Inquiry 1301.

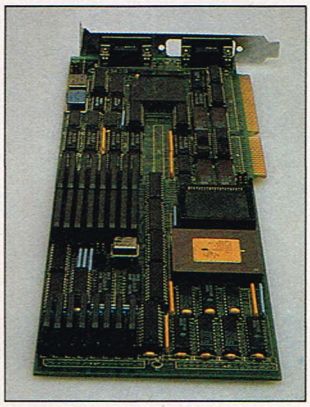
Graphics Controllers Do Unix, DOS, and OS/2

Using a 10-MIPS processor, the Info SGX graphics controller is 60 percent faster than other graphics processors, according to Nissei Sangyo America. You can further speed up the board with an optional coprocessor with dedicated program memory.

The Info SGX family of boards supports a range of resolutions of up to 1600 by 1280 pixels, including 8514/A, Super VGA, and VGA. All models support single- and dual-screen modes.

The graphics boards install in a single card slot and come with drivers for major DOS applications. Drivers for OS/2 Presentation Manager and the X Window System are also available.

Price: $4295 and up.
Contact: Nissei Sangyo America, Ltd., 800 South St., Waltham, MA 02154, (800) 441-4832 or (617) 893-5700.
Inquiry 1302.

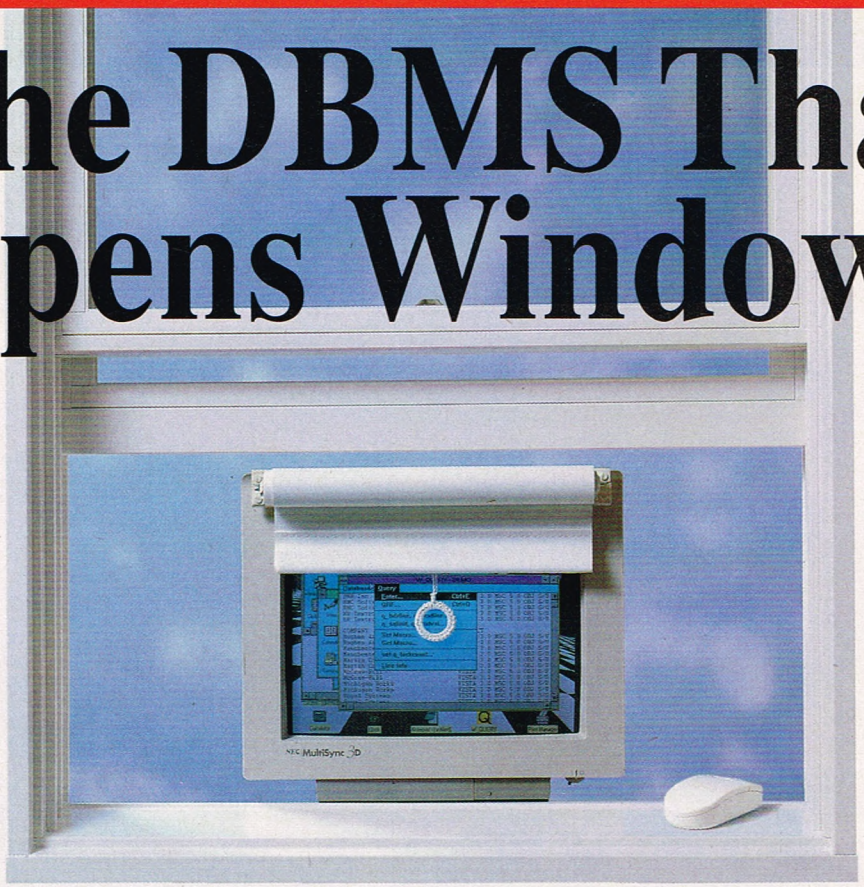


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Zirco's PowerTrip lets you power up a computer, fax machine, or any other AC device from an automobile cigarette lighter.

PowerTrip provides 100 W of continuous 115-V AC power. It features a low-battery alarm, a power switch, a safe-power light, and surge suppression—and it's small enough to fit in your shirt pocket, according to Zirco.

PowerTrip also comes in an international version, which converts power from a vehicle cigarette lighter to 100 W of 220-V AC power.

Price: $199.95.
Contact: Zirco, Inc., 10900 West 44th Ave., Wheat Ridge, CO 80033, (303) 421-2013.
Inquiry 1304.

Brackets for Your Hardware Keys

Are your hardware keys forming a key chain behind your computer? If so, you might need an adapter bracket.

Software Security has such a device, which fits into an empty slot in your PC and keeps your hardware keys out of the way. The company claims that the device is difficult to remove, so it adds even more security than the hardware keys alone.

Price: $15.
Contact: Software Security, Inc., 1011 High Ridge Rd., Stamford, CT 06905, (800) 333-0407 or (203) 329-8870.
Inquiry 1305.



PowerTrip gives you AC power on the road.

Safeguarding Intellectual Property with Hardware Keys

SentinelScribe is an execution control device designed to help software developers safeguard application programs from unauthorized use.

Rainbow Technologies says that it is the first field-writable memory-based hardware key. The key contains 120 bytes of EEPROM, which is enough to protect more than one software program, according to Rainbow. "Field writable" means that your software applications have the ability to write to SentinelScribe's memory.

The key connects to the computer's parallel printer port. It operates transparently but must be present for the software to run. It executes a password system customized by the software developer.

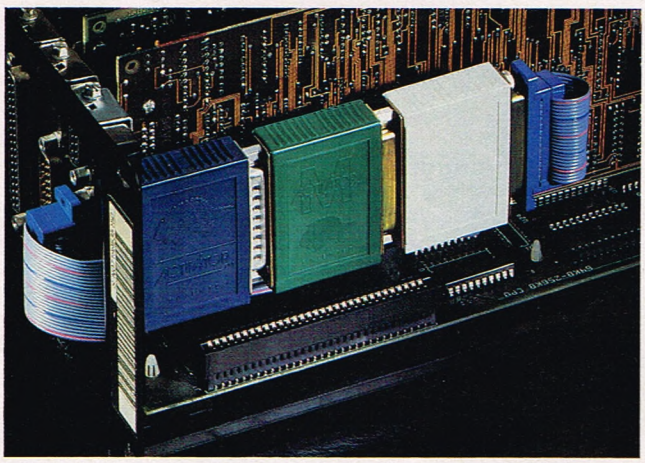
Price: $39.
Contact: Rainbow Technologies, 9292 Jeronimo Rd., Irvine, CA 92718, (800) 852-8569 or (714) 454-2100.
Inquiry 1306.

Extend Yourself with the SCSI Plus

If your SCSI devices are too far apart, the SCSI Plus Bus Repeater will give you an additional 19 feet of extension, or you can daisy chain them to any desired length.

Applied Concepts says that the SCSI Plus is easy to install. It hooks directly into standard SCSI adapters. It's completely transparent to the user, according to the manufacturer, and supports 5-MBps data transfers over a distance of 19 feet.

Price: $350.
Contact: Applied Concepts, Inc., 5350-H Eastgate Mall, San Diego, CA 92121, (619) 453-0090.
Inquiry 1307.



Software Security's adapter brackets hold a line of hardware security keys in place.

A Friendly Programmer from Xeltek



The Logic Universal Programmer for programmable logic devices works with PLDs from all manufacturers, according to Xeltek. The Programmer offers an interface that combines pull-down menus, windows, and a command line.

Price: $395.
Contact: Xeltek, 764 San Aleso Ave., Sunnyvale, CA 94086, (800) 541-1975 or (408) 727-6995.
Inquiry 1308.

12-V Battery Tester

The Performance Universal 12 Volt Battery Tester determines the condition of lead-acid batteries, including maintenance-free types such as sealed, recombination, and gel cells. It subjects the battery to an 80-amp load for 10 seconds and indicates whether the battery is good, weak, or bad. Pin jacks on the tester accommodate an auxiliary voltmeter that allows precise measurements during testing. The 2½-pound tester resides in a thermoplastic case.

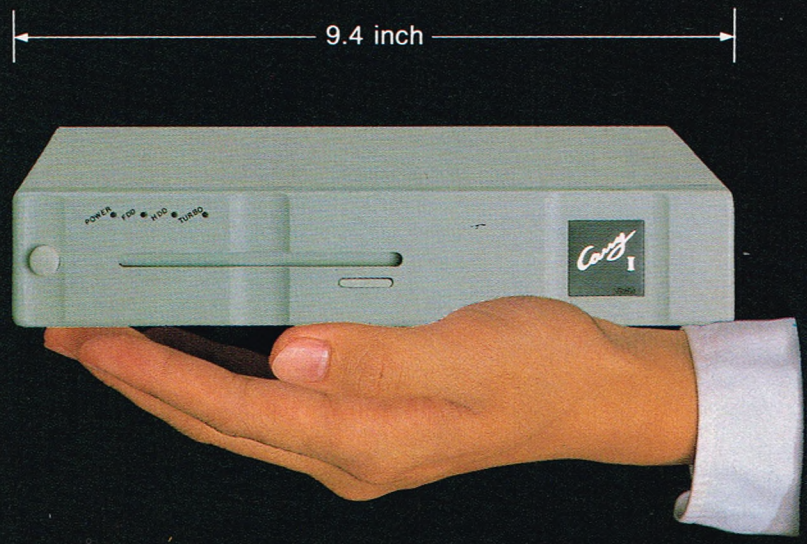
Price: $239.
Contact: Performance Technological Products, P.O. Box 947, Roswell, GA 30077, (404) 475-3192.
Inquiry 1309.

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The Carry-I 9000 series comes complete with 80386SX/80286-16/80286-12 microprocessor (Co-Processor optional), 1024×768 VGA/MGA & CGA display interface, 1/2/4 MB RAM, one 3.5" 1.44 MB FDD or one FDD plus one 40/80 MB HDD, one 8 bit expansion SLOT, one parallel and two serial I/O ports, and one 30W auto range switching power adapter, all in the traditional 240mm×185mm×45mm (9.4"×7.3"×1.8") casing of Carry-I. Each package includes two mini-tower stands and a carry bag. The 82 key mini keyboard and 9 inch color or monochrome VGA monitor are optional.

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Circle 138 on Reader Service Card

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Remote-Control VGA Displays

Network Technologies' SM-8×4-15V video matrix switch lets you connect up to four VGA displays to up to eight computers and remotely control the displays from up to 1000 feet away with the SM-RMT-8×4 remote unit.

The system comes in two parts: the matrix switch and the remote-control unit. The remote unit has 32 backlit and touch-activated switches for choosing which VGA to control. Each VGA source on the control unit can be connected to one or all four VGA displays.

The remote-control unit connects to the matrix switch via a 5-pin DIN connector. It comes with a 25-foot cable for connecting to the switch.

The matrix switch comes with eight 6-foot VGA cables for connecting to the eight systems. It measures 8½ by 11½ by 12 inches.

Price: Matrix switch, $2450; remote unit, $525.

Contact: Network Technologies, Inc., 19145 Elizabeth St., Aurora, OH 44202, (800) 742-8324 or (216) 543-1646.

Inquiry 1310.



You can remotely control up to four VGA displays from eight systems with Network Technologies' matrix switch (bottom) and remote-control unit (top).

Low-Priced LAN Control

LAN Command is LAN management software that combines database management with low-level network analysis. It loads on one client workstation, requiring 260K bytes of RAM. From that workstation, LAN Command can monitor and control your entire Novell or NetBIOS-based network.

The relational database system tracks node data (including user name, location, phone number, address, and node name) and more than 50 additional fields. Portions of the database are populated automatically by the network-monitoring commands to build a traffic history for every node.

A report generator provides standard and custom reports using Boolean operators on any field in the record. For example, the administrator might request a custom report for every Ethernet node on the fourth floor that uses a server named Accounting and has been rebooted more than five times in the last week.

Other monitoring features include packet activity, collisions, ring faults, bridge failures, router failures, bandwidth use, traffic errors, and data loss. And you can monitor single stations, sets of stations, or the entire network across bridges and routers from any single DOS or OS/2 workstation.

A TSR program called Snooper lets you perform remote administration of the client computer.

Price: $395.

Contact: Dolphin Software, Inc., 6050 Peachtree Pkwy., Suite 340-208, Norcross, GA 30092, (404) 339-7877.

Inquiry 1311.

continued

ISDN Communications with a PC

The PC SNET Card is an ISDN terminal adapter board that provides ISDN basic rate access. It allows simultaneous voice, data, and image transmission.

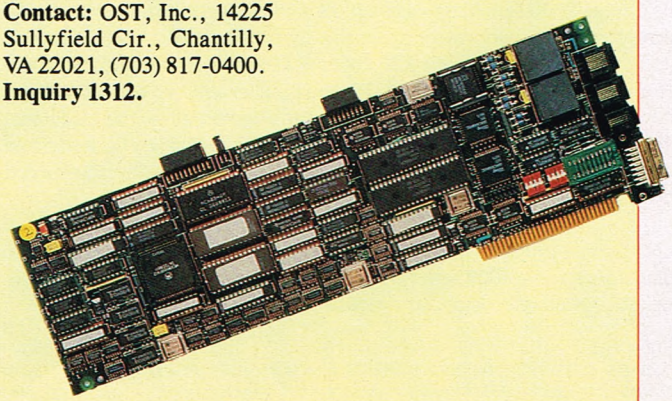
One card has an aggregate throughput of 144,000 bps. This is made up of transparent data transmission at 64,000 bps over two B channels and 16,000-bps packet signaling over the D channel, OST reports. You install the card in a full-size expansion slot in the PC. It operates under DOS, Unix, or Xenix.

The card provides the standard S-type connection along with an audio jack, an RJ-11 modular telephone jack, and a 15-pin serial connector. Internal connections include a parallel connector, a private bus connector, and a bus interrupt connector for use in installing multiple PC SNET Cards in a single PC.

Price: $1695.

Contact: OST, Inc., 14225 Sullyfield Cir., Chantilly, VA 22021, (703) 817-0400.

Inquiry 1312.





INSTANT WORKSTATION. JUST ADD OPEN DESKTOP.

Take a look at the vast majority of graphical workstations developed over the past decade and you'll see something they all have in common:

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Open Desktop is the complete graphical operating system that's built on the most popular UNIX System platform of all time—SCO™. And it lets you create your own networked, icon-driven workstation environment using the industry-standard 386 or 486 computers and peripherals of your choice.

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"It's significantly faster in some very important areas, especially in the fancy, attractive user interface... It's a very stable product, very reliable. I can safely recommend it."

PAT ADAMS
President, DB Unlimited, Brooklyn, NY:

"With standardization on the dBASE IV language, we have our database standard, which makes life easier for me, for my clients, and every other dBASE user... It's a solid, reliable product that performs the same way every time."

BOB DAVIES
President, SBT, Sausalito, CA:

"Memory utilization is much better than either dBASE III PLUS or dBASE IV version 1.0—a very substantial improvement. This means we are able to run our products, which require lots of memory and the need for a network, in a dBASE IV 1.1 environment."

SCOTT ROBERTSON
President, Champion Business Systems, Golden, CO:

"We think that it's solid. We think it's reliable. We think it's an excellent foundation for future development. The great thing about dBASE IV is that it has a flexible language and a good user interface. With dBASE IV version 1.1, end-users can take the product and tailor it so it fits their exact needs."

After running their own extensive tests, these independent experts have come to some very favorable conclusions on dBASE IV® version 1.1. We think you will, too.

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E IV Version 1.1.

TONY LIMA
Author of "Inside dBASE IV," President, Pacific Systems Design Workshop Inc., San Carlos, CA:

"Version 1.1 should dominate the market. Its added features make it the best development environment available for PC database products ... None of the other products have the power and ease of the dBASE IV Control Center."

HOMER BRANCH
Programmer Analyst, Chevron CEPS, New Orleans, LA:

"I'm using version 1.1 to develop applications right now... It's much easier to use than either dBASE III PLUS or 1.0... Because of the Control Center, version 1.1 allows my users to do queries and get their reports without calling me."

RICHARD BRENNER
President, Westar Systems, Colorado Springs, CO:

"I'm now taking on some major consulting jobs that I wouldn't do before dBASE IV and its multiuser capabilities... I'm excited about the way they've gone through and enhanced just about every one of the new features within the program and the programming language."

SAM GILL
President, DataWiz International, Foster City, CA:

"dBASE IV version 1.1 is significantly faster... Memory management has really been improved. We can now load and run a system very comfortably in 640K bytes... Features like the form, report and application generators allow us to cut down development time."

Call 1-800-437-4329, ext. 1403, for more information. Better yet, call 1-800-2ASHTON for an immediate upgrade.

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Wireless Communications

The DR 96 is an asynchronous/synchronous half-duplex modem that offers portable and wireless data transmission. Both the radio and the modem are contained in the same 15½-ounce package.

The DR 96 uses the radio frequency band of 470 MHz and has a sensitivity of .35 microvolts. The unit also offers 10-ms RTS (request to send) and CTS (clear to send) signaling times.

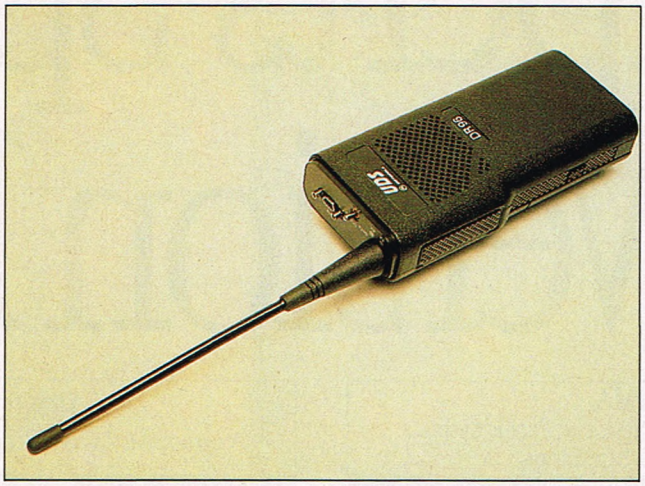
A rechargeable 7½-V battery pack that comes with the modem can operate it for from 4 to 10 hours. A recharger is also included that can recharge the batteries in 3 hours, according to UDS.
Price: $1295.
Contact: UDS, 5000 Bradford Dr., Huntsville, AL 35805, (205) 430-8000.
Inquiry 1313.

Modem with a Memory

The Visionary 2400XT is a direct-connect 2400-bps modem with battery-backed internal memory and a real-time clock/calendar to control when you send and receive messages. A blinking message-waiting light lets you know when you have messages. You can even send and receive messages when the host computer is turned off. All this internal intelligence is controlled by an 8085 microprocessor.

In addition, you can store dozens of phone numbers and messages for distribution at various times. Other features include redialing on busy or no answer, auto-answer during particular times only, automatic log-on, data retrieval, XMODEM file transfer, remote access, and password security. The modem also has a printer port and a nickel-cadmium battery.

The modem is available in three versions: 8K-byte, 256K-byte, and 1-MB. It measures 5¾ by 8$^{3}/_{10}$ by 1½ inches.
Price: 8K-byte unit, $495; 256K-byte unit, $595; 1-MB unit, $745.
Contact: Visionary Electronics, Inc., 141 Parker Ave., San Francisco, CA 94118, (415) 751-8811.
Inquiry 1314.



The DR 96 is a wireless, battery-powered modem for portable communications.

Notework Moves Out into the Field

Notework recently announced Notework Remote, a remote version of its 5K-byte Notework E-mail program. Remote allows laptop users or branch offices to pop up Notework over the phone line. The software automatically makes the connection and does the uploading or downloading of mail.

Like the original Notework for Novell NetWare, Remote takes up only 5K bytes of RAM, employs the same user interface, and lets you pop into it without leaving your application.

Notework alerts you with a tone when you receive mail, and you see a flashing symbol in the upper-right corner of the screen. Other features let you attach files, print notes, confirm notes, and import and export ASCII files. Notework offers a gateway to Message Handling Service.

The most recent version of Notework now supports multiple NetWare 386 servers without requiring additional gateways or mail servers. Version 1.1.4 supports up to 3500 users on a single internetwork, according to Notework.
Price: $99; installation kit, $99; two-user authorization disk, $99.
Contact: Notework Corp., 72 Kent St., Brookline, MA 02146, (800) 767-6683 or (617) 738-5295.
Inquiry 1315.

Linking Buildings via Infrared Light

Building-to-Building Photolink lets you connect computers in adjacent buildings up to 600 feet away, according to Photonics.

Two versions of Photolink are available: AppleTalk/LocalTalk for the Mac, and an interface for systems equipped with RS-232C ports.

At the end of each connection is a Photolink transceiver that communicates with its corresponding unit. Photonics says that the device can operate through two panes of standard office window glass.

Photolink can connect to existing cable-based systems and is compatible with AppleTalk routers and bridges. It transmits at 230,400 bps. The RS-232C version transmits up to four channels simultaneously at 9600 bps.
Price: $3390 per connection for both versions.
Contact: Photonics Corp., 200 East Hacienda Ave., Campbell, CA 95008, (408) 370-3033.
Inquiry 1316.

Modem Sharing for Networks

Modem Assist lets you share up to 20 modems connected to a LAN. It eliminates the need for a dedicated communications server and the cost of rerouting all modem phone lines, according to Fresh Technology Group.

The software works with multiport serial cards that support up to 16 modems on a single workstation. It requires less than 10K bytes of RAM and runs in the background on any workstation with the modem.

Modem Assist requires PCs running on NetBIOS or NetWare networks with DOS 3.0 or higher.
Price: $495 for up to five modems; $995 for six to 20 modems.
Contact: Fresh Technology Group, 1478 North Tech Blvd., Suite 101, Gilbert, AZ 85234, (602) 497-4200.
Inquiry 1317.

continued

Programmer's Paradise has the Utilities that you need !

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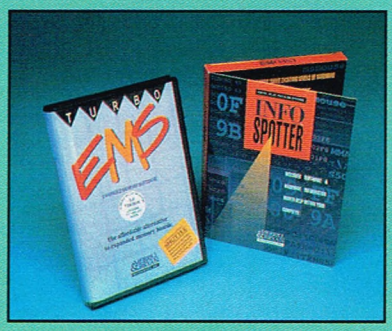
MERRILL & BRYAN ENTERPRISES, INC.

TURBO EMS – Memory Manager

- Supports PC, XT, AT, PS/2, and 386 systems
- Ability to relocate TSRs and device drivers
- Automatic installation and configuration on 386 systems
- Windows 3.0 support

FAXcetera #2273-0001

List: $99.95 Ours: $89



InfoSpotter – Diagnostic tool

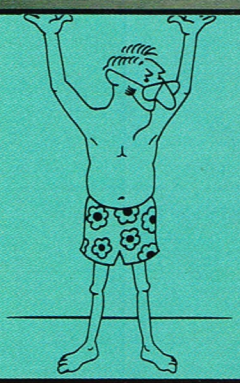
- Detailed description about memory and system configuration
- Displays TSRs and device drivers loaded between 640KB and 1 MB
- Ability to edit AUTOEXEC.BAT, CONFIG.SYS and batch files
- Special MicroChannel support

FAXcetera #2273-0002

List: $79.95 Ours: $69

HIJAAK RELEASE 2.0





HiJaak 2.0 is a graphics conversion and capture utility that translates more than 36 graphics file formats. HiJaak provides batch conversion capability from the DOS command line or from the user interface.

Supported formats: GEM, PICT I&II, GCM, HPGL, PIC, DXF, PCX, MAC, TIF, and support for more than 16 group 3 fax devices. A 5K pop-up provides capture function of text screens, graphics screens, and laser printer output.

FAXcetera #1976-0002

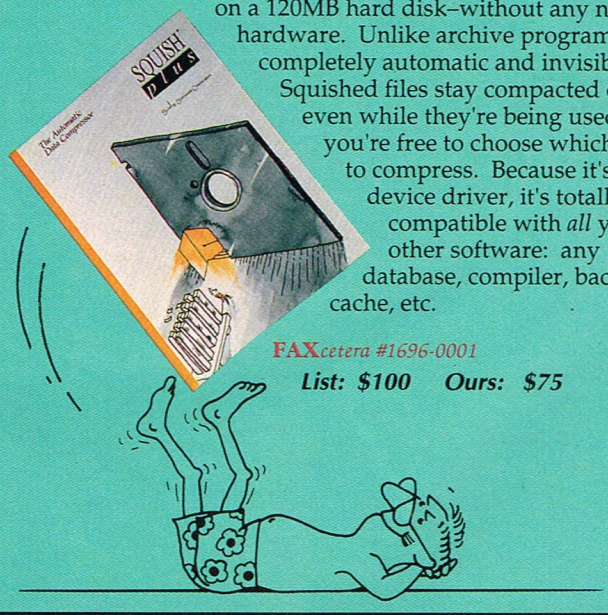
List: $199 Ours: $139

Inset Systems

SQUISH PLUS

Sundog Software Corp.

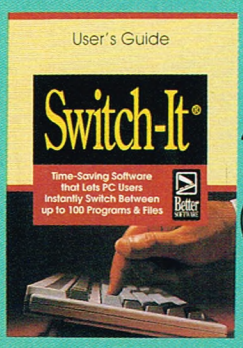
Squish Plus can enlarge the capacity of all your disks–hard, floppy, or silicon. By compressing data, it can get up to 240MB on a 120MB hard disk–without any new hardware. Unlike archive programs, it's completely automatic and invisible. Squished files stay compacted on disk even while they're being used, and you're free to choose which files to compress. Because it's a device driver, it's totally compatible with *all* your other software: any database, compiler, backup, cache, etc.

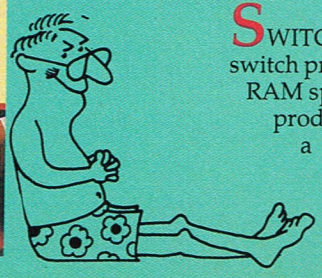


FAXcetera #1696-0001

List: $100 Ours: $75

SWITCH-IT



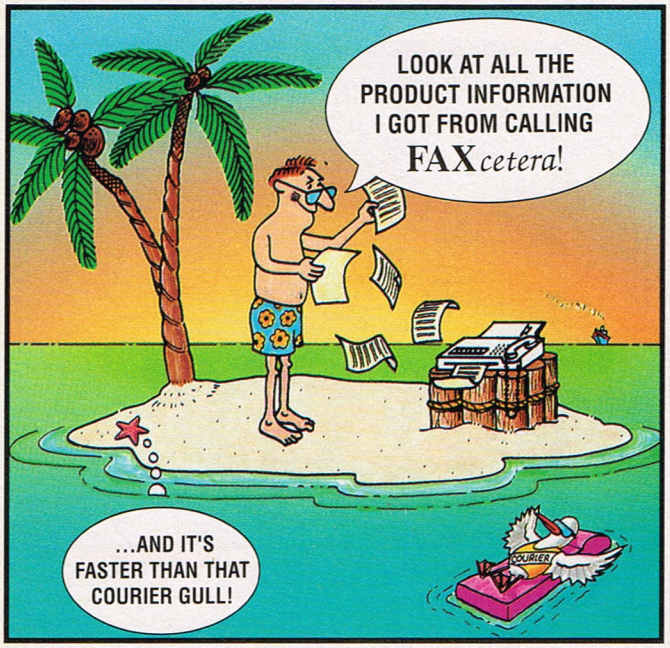


SWITCH-IT is a task-switching package that allows users to switch programs (up to 100) to their EMS or hard disk, freeing up RAM space to run large applications. The easiest to use of any product of its kind, SWITCH-IT offers automatic installation, a customizable menu, a cut & paste feature, complete network compatibility ***and*** SWITCH-IT only uses 26K of RAM.

Better SOFTWARE

FAXcetera #2396-0001 **List: $100 Ours: $69**

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386 CONTROL PROGRAMS

	LIST	OURS
DESQview 386 w/ QEMM	220	169
Microsoft Windows 3.0	150	99
VM/386	245	209
VM/386 MultiUser	895	839
VM/386 MultiUser Starter	395	339

386 DEVELOPMENT TOOLS

386 ASM/LinkLoc	1295	1145
C-Terp 386	239	189
Lahey F77L-EM/32 (w/ OS/386)	1290	1035
MetaWare High C 386	895	849
Novell C Network Compiler/386	995	799
Paradox/386	895	629
PC-lint 386	239	179
Phar Lap 386 ASM/LINK	495	435
WATCOM C 8.0/386 Prof. w/ Phar Lap 386 ASM/LINK	1295 1790	1099 1399
WATCOM C 8.0/386 Standard	895	719

ADA

Academic IntegrAda	249	225
Ada Scope Debugger	495	445
Ada Training Environment	895	809
Adagraphics	695	629
IntegrAda	795	719
Meridian AdaStudent	50	45
Meridian Ada Developer's Kit	1195	1095

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Advantage Disassembler	295	279
ASMFlow	99	89
Dis Doc Professional	250	225
MS Macro Assembler	150	105
OPTASM	150	129
Re:Source	150	129
Sourcer w/ Pre-Processor	170	149
SpontaneousAssembly	395	189
Turbo Debugger & Tools	150	105
Visible Computer: 80286	100	89

BASIC COMPILERS

MS BASIC Prof. Devel. System	495	349
Power Basic	129	89
QuickBASIC	99	69

BASIC LIBS/UTILITIES

GraphPak Professional	149	129
P.D.Q.	129	115
ProBas	159	149
ProBas Toolkit	99	94
QBase and Quickscreen	149	125
QuickComm	149	119
QuickPak Professional	169	149
QuickWindows Advanced	149	119

C COMPILERS

Lattice C 6.0	250	155
Microsoft C 6.0 w/ Objective-C	495 699	339 539
MS QuickC 2.5	99	69
MS QuickC w/ QuickAssembler	199	139
Turbo C 2.0	99	69
WATCOM C 8.0 Professional	495	419
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C++

C++/Views	495	419
NDP C++	495	479
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Rogue Wave Tools.h++	200	179
Turbo C++	200	139
Turbo C++ Professional Competitive Upgrade	300 150	205 139
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c-tree	395	315
dBC III Plus	500	439
db_FILE Bundle	295	249
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FairCom Toolbox - Prof. Edition	1095	789
FairCom Toolbox - Special	695	509
Paradox Engine	495	349

C-GENERAL LIBRARIES

Blackstar C Function Library	99	79
C TOOLS PLUS/6.0	149	109
C Utility Library	249	199
Greenleaf Functions	229	179
Greenleaf SuperFunctions	299	239
Turbo C TOOLS/2.0	149	109

C SCREENS

C-Worthy	399	CALL
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QuickWindows Advanced (C)	169	149
Vermont Views	495	395
Vitamin C VC Screen	225 149	165 125

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Bar Code Library	389	319
Clear +	200	169
C Shroud	198	149
DIVVY	229	209
Heap Expander	80	70
MKS LEX & YACC	249	197
Objective-C	249	225
PC-lint	139	105
.PCYACC Professional	495	459
TimeSlicer	295	279

CASE TOOLS

EasyCASE Plus	295	265
Professional Pack	395	355
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COBOL LANGUAGE

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MS COBOL	900	629
Realia COBOL	995	849

CODE GENERATORS

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DATABASE DEVELOPMENT

Clarion 2.1	CALL	CALL
Clipper 5.0	795	519
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dBASE IV	795	489
dBFast/PLUS	345	295
dGE	295	249
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Facelt	99	90
FlashTools!	89	79
Flipper	195	169
Force 2.1	695	589
FoxPro	795	489
FUNCKy Library	195	179
R&R Report Writer	150	129
R&R Code Generator	150	129
Say What?!	50	39
SilverComm C Interface	99	89
SilverComm Library 2.0	249	209
Tom Rettig's Library	100	80
UI2 Version Two	595	479

DEBUGGERS (DOS)

MultiScope	179	135
Periscope I/512K	595	475
Periscope II w/ switch	225	179
Periscope IV/16, 25 MHz	CALL	CALL
Trapper	200	179
w/ optional cable	240	219
Turbo Debugger & Tools	150	105

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Clear+	195	169
C-Clearly	130	115
Flow Charting 3	250	199
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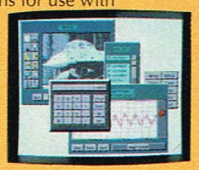
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Menuet - The GUI Development Toolkit.

Menuet is a sophisticated, simple solution for Graphical User Interface (GUI) development that provides over 400 callable functions and supports most all GUI constructs. It is currently available in versions for use with MetaWINDOW, from Metagraphics Software Corporation, and GSS*CGI, from Graphics Software Systems. Other Ithaca Street products include: UpShot, PiXelPrint, Font-Tools, Icon-Tools, and Baby Driver.



List: $325 ***Ours: $279*** **FAX*cetera* #2263-0003**

WindowsMAKER

WindowsMAKER is a code generator that builds complete Windows 3.0 applications. Prototype the entire user interface (menus, icons, buttons, controls, etc.) in a WYSIWYG editor, then generate Microsoft C code for MS-Windows. Custom code is preserved during regeneration. WindowsMAKER handles message processing, memory management, child windows, debugging, compiler settings, MDI and much more. Generates excellent C code. Port DOS programs to Windows in record time. A must if you are writing applications for Windows in C. 30 day money-back guarantee.



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List: $595 ***Ours: $535*** **FAX*cetera* #2602-0002**

WATCOM C8.0/386

WATCOM C8.0/386 is a 100% ANSI C optimizing compiler and run-time library for the Intel 80386 architecture generating applications for 32-bit protected mode. With C8.0/386, you can go beyond the 640K DOS limit. Library and source code compatibility with Microsoft C simplifies many porting projects. Significant features include: protected mode version of the compiler; VIDEO full-screen source-level debugger; Microsoft library and source compatibility; execution profiler; high-performance linker; graphics library.



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SpontaneousAssembly

An assembly language library that lets you produce the fastest, tightest possible programs with the same ease you'd expect from a high-level language. It includes an impressive collection of over 700 functions and macros for high-speed text windowing, heap management, array searching and sorting, critical error management, 32/64 bit integer math, and much more! Comprehensive 750+ page manual. Full source code. No royalties. Easy integration with C.



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- Michael Abrash

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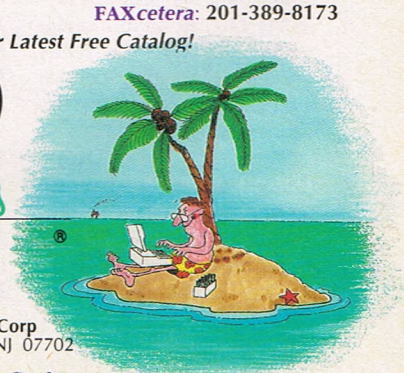
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Unix Programming Environment Has All the Tools

Saber Software has brought its environment for Unix workstations up to speed to support all phases of C programming, including development, debugging, testing, and maintenance. Saber-C 3.0 lets you debug code handled by the interpreter, object code produced by the compiler, or libraries. You can use Saber-C to set breakpoints and to step, trace, and debug object and source code modules.

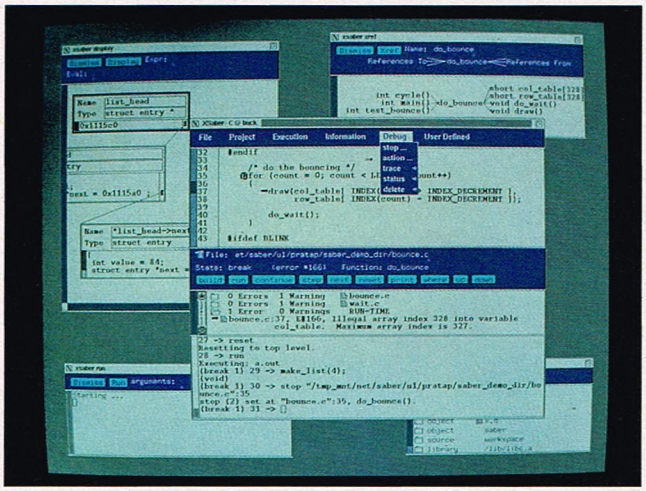
Saber-C includes a multiwindow graphical interface that you can customize by defining commands and new buttons. Saber-C automatically detects more than 250 static and run-time errors.

Saber-C runs on Sun-3 and Sun386i workstations, SPARCstations, DECstations running Ultrix, and ASCII and X Window System terminals.

Price: $2495.

Contact: Saber Software, Inc., 185 Alewife Brook Pkwy., Cambridge, MA 02138, (617) 876-7636.

Inquiry 1271.



Saber-C 3.0 combines an incremental linker, static and run-time error detection, source-level debugging, and a multiwindow interface in one system.

Zinc Releases Class Library for C++

With Zinc's user interface class library for Borland's Turbo C++ you can create a user interface for a DOS application without having to develop the interface from scratch. The Zinc Interface Library 1.0 lets you write applications that run in true graphics and text modes, including on dual monitors, from one set of source code without recompiling or relinking, the company says. The library also supports 20 input field types with built-in cut-and-paste and full Undo and Redo.

By calling the Zinc BBS, you can download additional capabilities for Zinc 1.0, including support for both the MetaWindows Graphics Library and Borland's Graphical Interface.

Other features on the BBS include enhanced scroll-bar support to provide both vertical and horizontal scroll bars in the window object, in addition to vertical scroll-bar support for text and matrix objects. Zinc has also added a new List object with full insert, delete, and modify capabilities.

The library exploits C++ features such as virtual functions, class inheritance, operator overloading, and multiple inheritance.

Price: $199.95; source code, $200.

Contact: Zinc Software, Inc., 405 South 100 East, Suite 201, Pleasant Grove, UT 84062, (800) 638-8665 or (801) 785-8900; BBS, (801) 785-8997.

Inquiry 1272.

New MitemView Supports the MacIRMA Family

Version 1.1 of MitemView, the HyperCard development tool that lets you create graphical user interfaces for accessing IBM mainframe applications, supports Digital Communications Associates' MacIRMA products, including coaxial and LAN-based System Network Architecture gateways. Mitem says 1.1 uses DCA's MacIRMA application programming interface to provide connectivity to the host.

MitemView simplifies the connection to VAX and IBM 3278 and 3279 mainframes, providing easier access and information retrieval for local processing without requiring modification of the host code. MitemView already supported Tri-Data's NetWay and Avatar's MacMainFrame products.

Price: Developer's toolkit, $995; MacIRMA driver, $495.

Contact: Mitem Corp., 2105 Hamilton Ave., Suite 190, San Jose, CA 95125, (408) 559-8801.

Inquiry 1275.

High-Level Routines for the Mac User Interface

MacInterface 1.1 automatically implements many segments of the Mac interface. The library supports the Undo and Redo of Edit menu commands without requiring coding on your part. It provides automatic support for the dragging, growing, and zooming of modal and modeless dialog boxes.

The program is compatible with Lightspeed C and Pascal, MPW C and Pascal, and several Modula compilers.

Price: $295.

Contact: Holder, Egan & Co., Inc., 4148 Spring Hill Rd., Midland, MI 48640, (800) 782-9976 or (517) 636-7373.

Inquiry 1273.

Structured Design Analysis for Windows

System Architect 2.1, the CASE tool for structured design analysis that runs under Microsoft Windows, lets you take an entity model similar to that of the IBM Repository and expand it graphically to show both key and nonkey data. It supports supertype and subtype relationships and provides for automatic synchronization of any two data dictionary types.

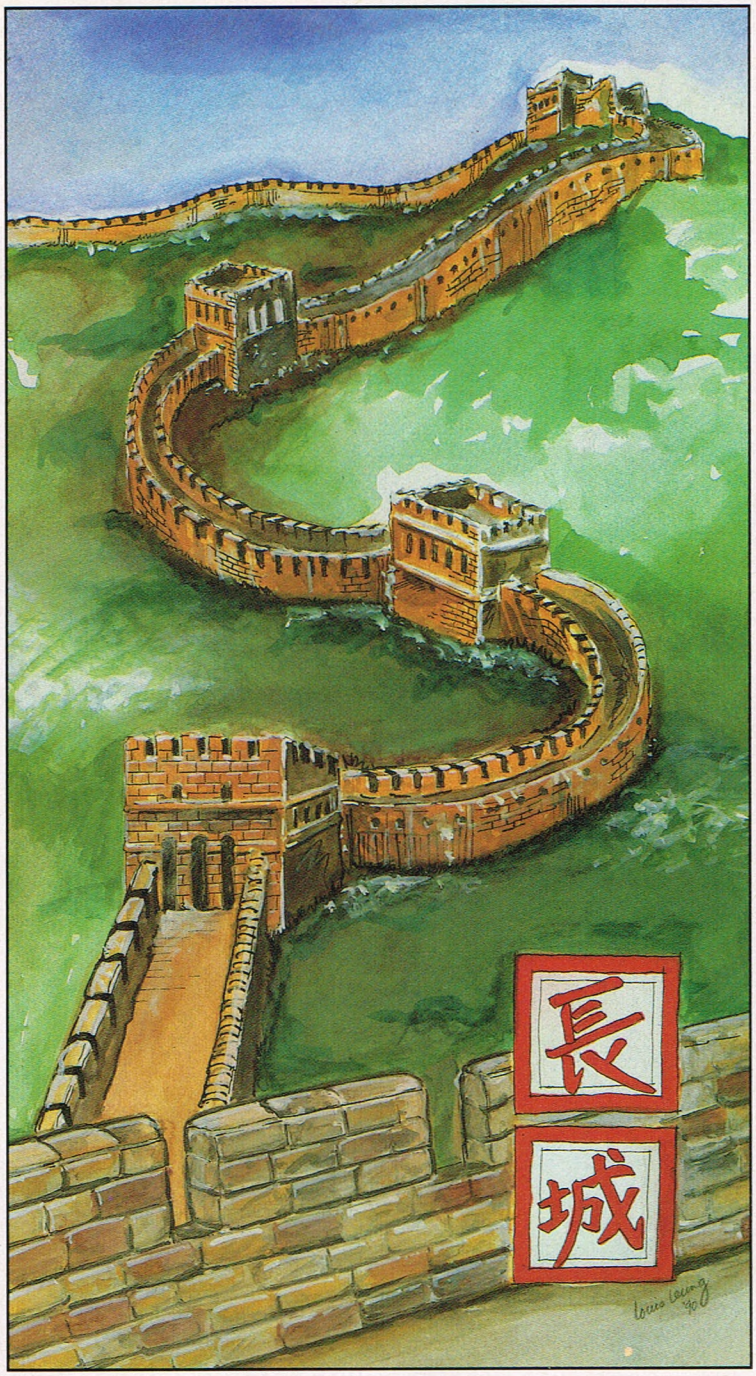
System Architect runs on an IBM AT with Microsoft Windows 3.0. An OS/2 Presentation Manager version is scheduled to ship by year's end.

Price: $1395; Booch Object Diagraming option, $495.

Contact: Popkin Software & Systems, Inc., 11 Park Place, 19th Floor, New York, NY 10007, (212) 571-3434.

Inquiry 1274.

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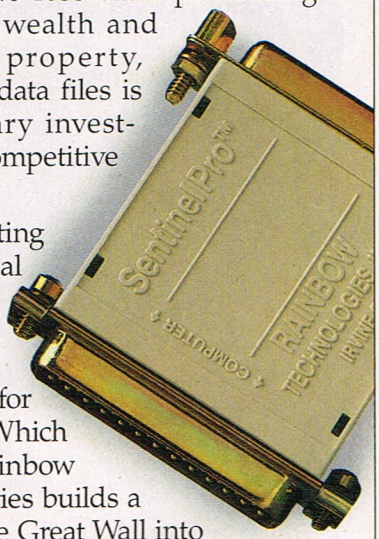


Whether you're protecting frontiers and temples in Manchuria, or software and data on the PC or Mac, the Great Wall is a lesson Rainbow Technologies has learned very well.

Software developers must deal daily with the consequences of unauthorized copies and millions of dollars in lost revenue. At the same time, both individual and corporate users must be able to make and distribute copies within legal guidelines.



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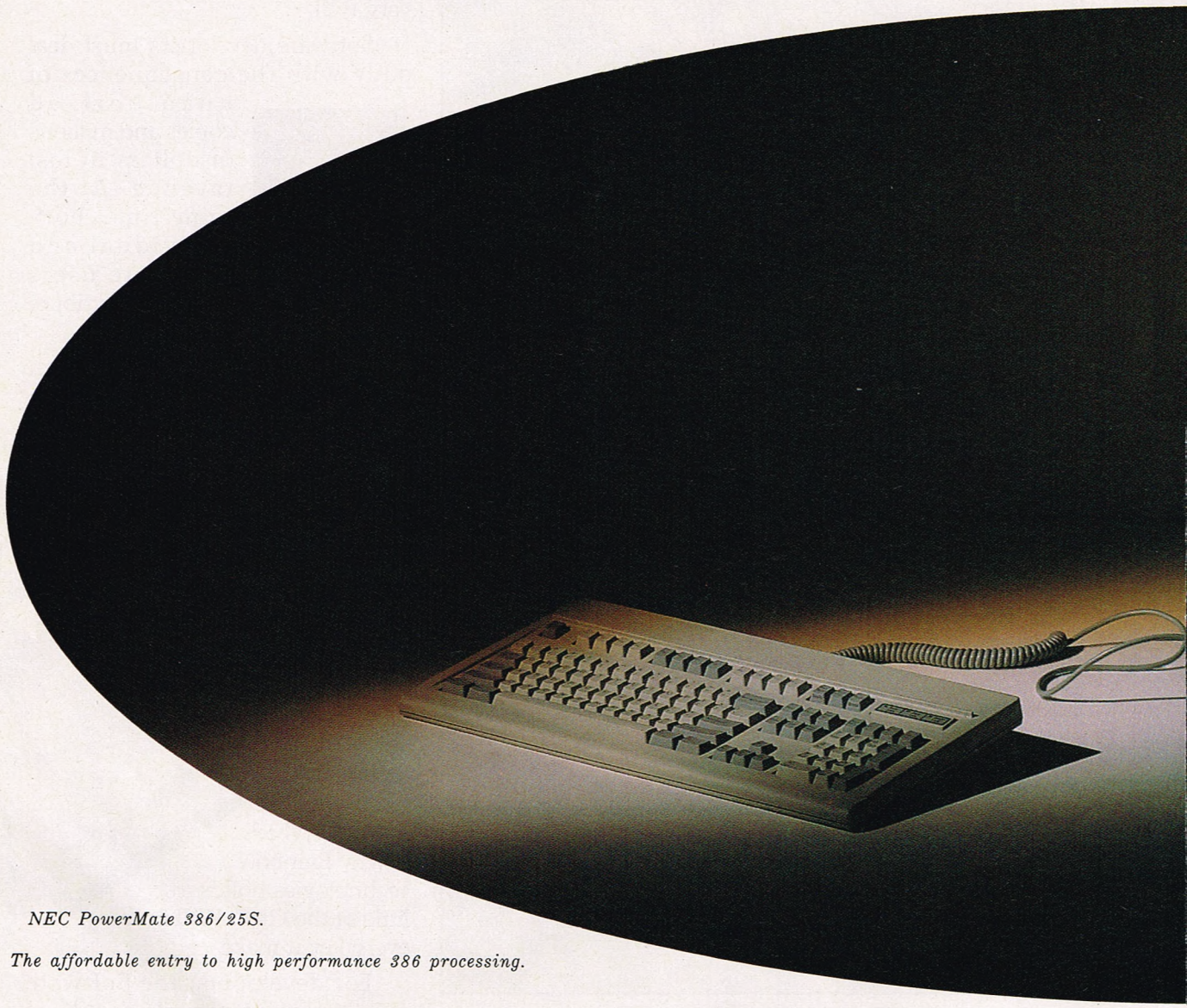
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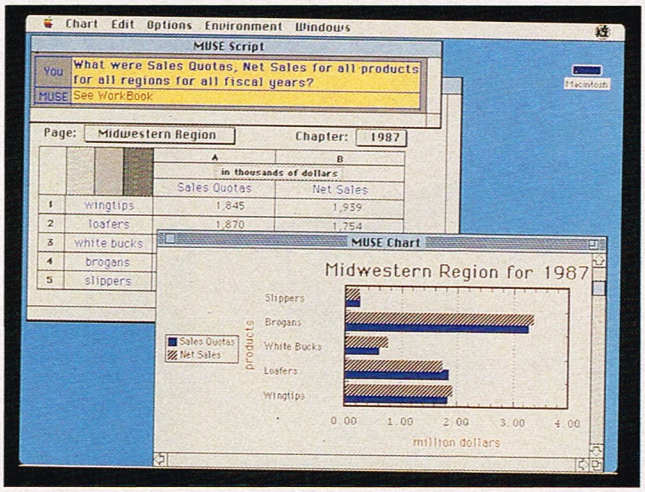
Occam Says, Go Ahead, Ask Me

Even with the best graphical user interface, it can still be difficult to find the right data in an acre-size spreadsheet and graph it appropriately.

Occam is addressing this problem with its new program for the Mac, called Muse. Muse lets you perform data retrieval, manipulation, and interpretation using English language through the keyboard or other input device such as the Voice Navigator. The program also lets you pull only the data you need from vast data sets and graph it immediately on your command.

Muse can import data in flat files, ASCII, DBF, WKS, and several other formats. The program organizes data in databooks, which you can set up to reflect company divisions such as personnel, manufacturing, or sales. As you ask or type questions in English, Muse retrieves the relevant data and puts it into a workbook with the level of detail you need. When you want to graph a workbook, you simply type or say, "Graph that," and Muse does the rest, automatically numbering graphs by titles, legends, axis identification, and data identification. Graphs can be 2-D, 3-D, or animations.

Occam is releasing Muse to a number of corporate sites this fall, with general distribution targeted for 1991.
Price: $695.
Contact: Occam Research Corp., 85 Main St., Watertown, MA 02172, (617) 923-3545.
Inquiry 1276.



Ask and you shall receive is one of Muse's concepts. Another is to provide only the data that you need.

Generate Database Applications with PAM

PAM (for Program Automated Method) 2.0, the relational DBMS that includes an application generator and natural user interface, adds new data types, new relational capabilities, matrix table processing, expanded database capacity, and many other features, while running in less than 256K bytes of RAM on the IBM PC.

Designed for nonprogrammers, PAM 2.0 lets you design applications with built-in field verification. Support for transaction processing allows multiple fields in multiple databases to be updated in a single screen. PAM 2.0 also supports mathematical operations for multiple fields in databases from one numeric entry, allowing for easy update.

Advanced relational capabilities link one database to multiple records in another database without the need for common fields.

Version 2.0 supports Hewlett-Packard laser printers and mail merge.
Price: $145 to $345.
Contact: Software Composers, Inc., 4500 Newcombe Dr., Plano, TX 75093, (214) 985-8018.
Inquiry 1277.

Put an International Business Expert in Your PC

For companies seeking to learn more about how to enter and succeed in the world marketplace, GateWaze has developed x-prime World Trader. The program's four integrated database modules let you look at information in a variety of ways through the use of hyperlinking.

The Market Analyst module provides a set of tools for analyzing the 50 major trading partners of the U.S.; the World Atlas module gives up-to-date information on 125 countries; the InfoDeck supplies a directory of international contacts; and the Export Reference Guide offers information on the exporting process. Other features include currency, weight, and measures information; time-zone calculations; and an international glossary.

The program runs on the IBM PC with 512K bytes of RAM.
Price: $289.
Contact: GateWaze, Inc., 66 Summer St., P.O. Box 743, Manchester, MA 01944, (800) 752-4711 or (508) 526-7406.
Inquiry 1279.

EASI Puts Forms and Database in One Package

FormType 3.0 provides a forms creator and dBASE-compatible relational database in one package, letting you use the information that's collected in day-to-day operations to help you make business decisions.

FormType 3.0 supports form fill-in and report generation. A LAN version is available.

With FormType 3.0, you can link several different form types to the same database. This lets you store common information such as name, address, or sales history in one place, although it is used repeatedly in various office forms, Easy Automation Systems says.

You can perform relational database operations and integrate and transfer common information among the forms, saving keystrokes and reducing input errors.

FormType 3.0 runs on the IBM PC with 640K bytes of RAM. A run-time version lets valve-added resellers and OEMs insert a company logo and application name into shrink-wrapped form sets.
Price: $229.95; run-time version, $99.95; LAN version, $695 per server.
Contact: Easy Automation Systems, Inc., 5555 Triangle Pkwy., Suite 440, Norcross, GA 30092, (800) 627-3274 or (404) 840-0474.
Inquiry 1278.

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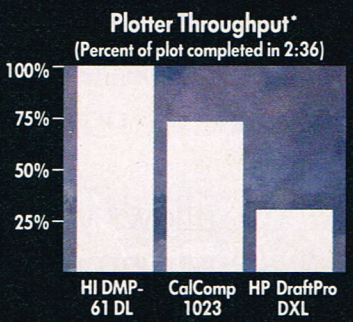
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O.K., let's settle this performance thing once and for all. **SPEED.** In a recent comparison of throughput for the three top selling plotters, the Houston Instrument DMP-61 DL came out on top. One-third faster than the CalComp 1023. Over three times faster than the HP DraftPro DXL. In other words, whatever you plot in one hour with us could take you all afternoon with them. **QUALITY.** We also deliver unsurpassed quality with identical mechanical resolution to CalComp and HP, and superior same pen repeatability. **VERSATILITY.** Only the Houston Instrument plotters offer Quick Scale™ where any size drawing can be easily scaled and plotted at the current media size, plus the capability to save up to six different user configurations in memory—all standard. **PRICE.** Best of all, the HI DMP-60 DL Series helps you beat the pants off **your** competition all at a very competitive price. For more information on the DMP-60 DL Series plotters call 1-800-444-3425.



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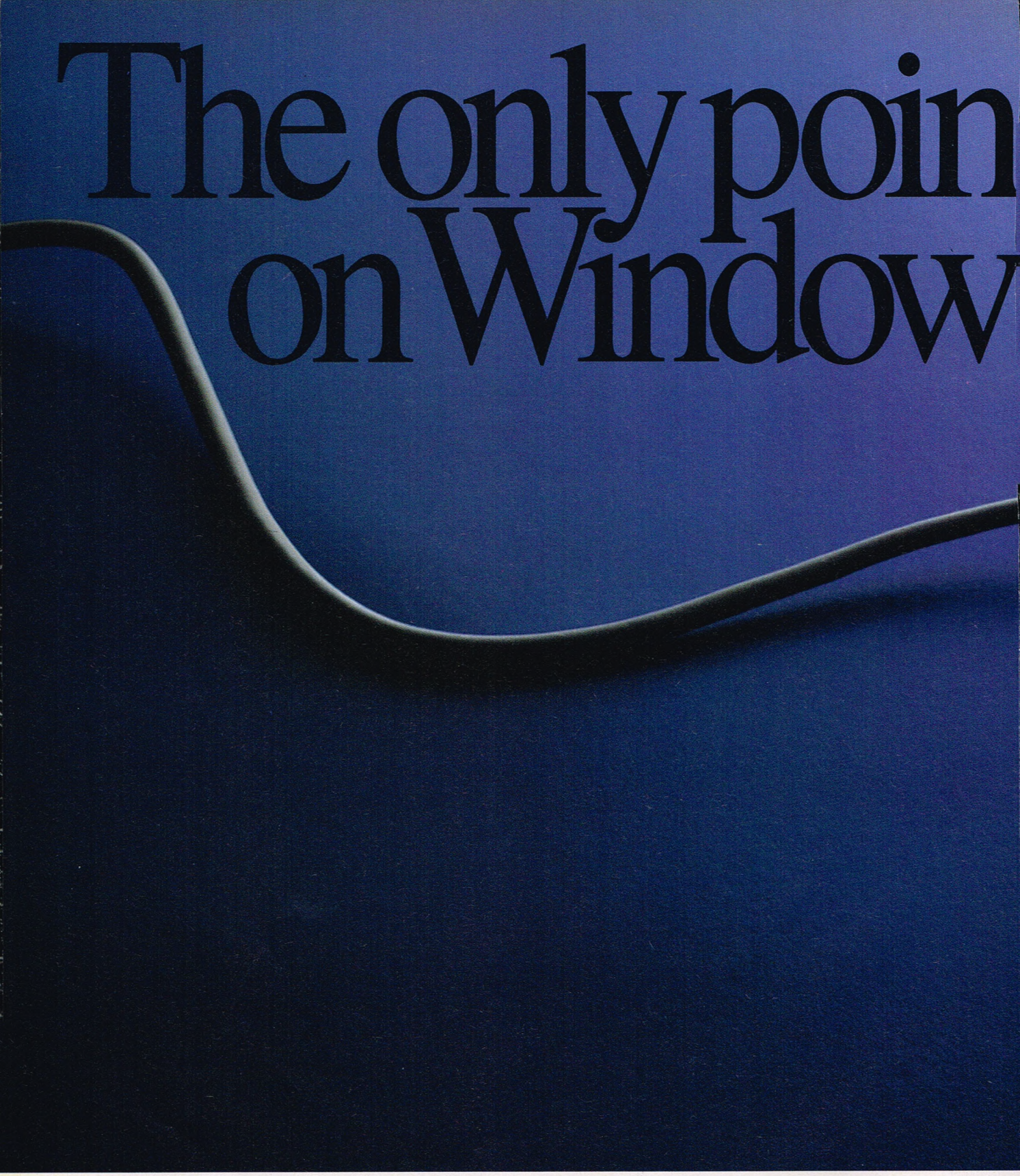
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For IBM/Compatible information circle 163, For Macintosh information circle 164, For Reseller inquiries circle 165 on Reader Service Card.

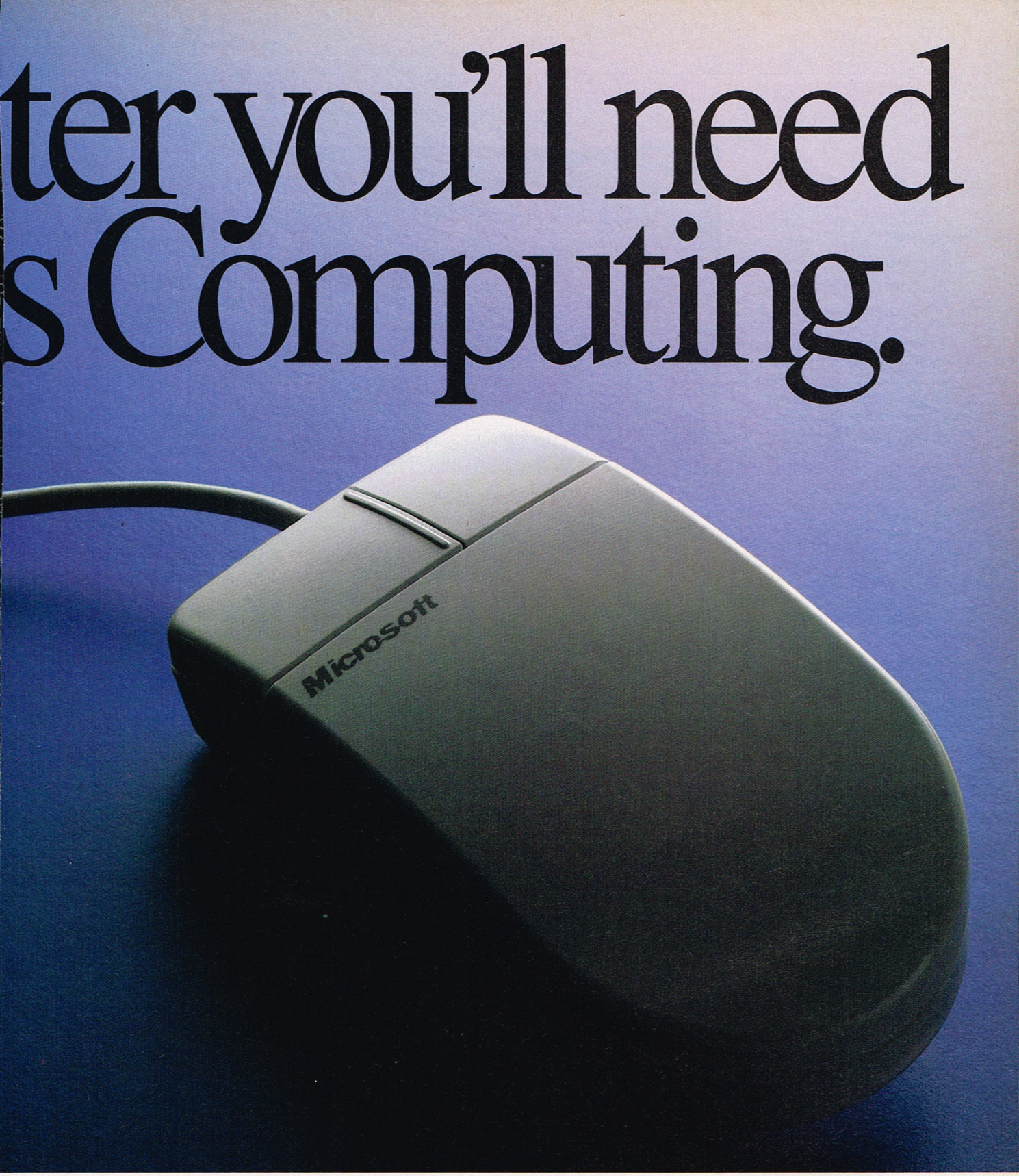


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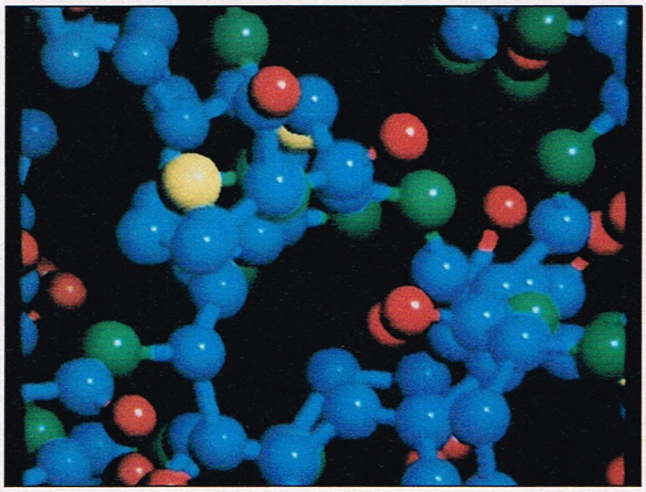
Visualize Protein Structures on the IBM PC

A molecular graphics tool called the Protein Visualizer lets you visualize how different chemicals and other substances interact with various molecules. The program lets you create 3-D models of complex protein structures and rotate, separate, and otherwise manipulate molecules for further study.

With the program, you can overlay up to four mixed-mode models at the same time. The overlays can show the interaction of substrates in an active-site cleft or hormones and their receptors, and capture the results.

Protein Visualizer features zooming, full-color space filling, and all-atom or main-chain display of up to 5000 atoms.

The program requires a 286 with VGA capability and 640K bytes of RAM. A hard disk drive is recommended.
Price: $495.
Contact: Synthetic Genetics, 10455 Roselle St., San Diego, CA 92121, (619) 587-0320.
Inquiry 1280.

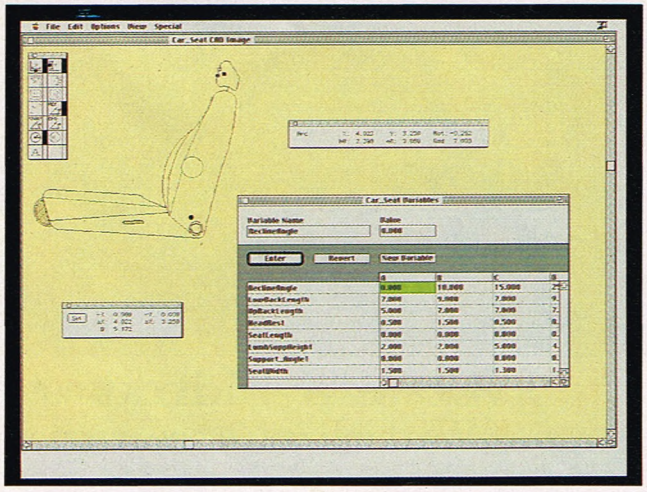


The Protein Visualizer lets molecular biologists and immunologists visualize protein structures in 3-D.

Real-Time Process Modeling with OS/2

With RT-Graphics, you can create and edit graphical symbols and integrate them with sensor monitoring, simulation, and other real-time applications running under OS/2 Extended Edition and Presentation Manager.

Animated presentations can be in the form of histograms, dials, fluid levels, or other graphics. You can set up an application so that a change in the graphical display of a process is reflected in the related alphanumeric text. This capability lets the program display numeric representations of sensor output values with their associated graphics symbols.
Price: $1100; developer's library, $800.
Contact: Commercial Software Dept., Farradyne Systems, Inc., 3206 Tower Oaks Blvd., Rockville, MD 20852, (800) 828-7863 or (301) 468-5568.
Inquiry 1281.



In addition to showing how your Mac CAD drawings will work, vPower can revise a drawing with new specifications and parameters, making multiple versions of the same drawing.

What-If CAD Analysis

Once you've completed a mechanical, architectural, or other drawing in VersaCAD, Claris CAD, PICT, or DXF format on the Mac, you can use vPower to describe the motion and rotation of objects. This what-if tool for CAD lets you see how your design works. A spreadsheet lets you assign up to eight value sets to an unlimited number of variables.

vPower runs on the Mac Plus with a recommended hard disk drive.
Price: $799.
Contact: Vision Software, 3160 De La Cruz Blvd., Suite 104, Santa Clara, CA 95054, (408) 748-8411.
Inquiry 1282.

Digital Elevation Model Data on CD-ROM

Two companies recently released digital elevation data from the U.S. Geological Survey on CD-ROM.

Rocky Mountain's CD-ROM set of 3-arc-second terrain elevation data has the contiguous U.S., Hawaii, and Puerto Rico.
Price: Complete set of five CD-ROMs, $3000; one CD-ROM, $1000.
Contact: Rocky Mountain Communications, Inc., 12844 West Iliff Ave., Lakewood, CO 80228, (303) 988-3395.
Inquiry 1283.

Micro Map & CAD's CD-ROMs are available in two grids: a 3-arc-second grid and a 30-arc-second grid for the entire U.S.
Price: Complete set of six CD-ROMs, $5000; one CD-ROM, $1000.
Contact: Micro Map & CAD, P.O. Box 621135, Littleton, CO 80162, (303) 973-2768.
Inquiry 1284.

Solve Math and Thermophysical Problems

In addition to solving algebraic and initial-value differential equations, the Engineering Equation Solver (EES) has a physical-property database to help you solve problems in the thermal sciences.

EES runs on the Macintosh with 1 MB of RAM and supports a math coprocessor if you have one.
Price: $400.
Contact: F-Chart Software, 4406 Fox Bluff Rd., Madison, WI 53562, (608) 836-8536.
Inquiry 1285.

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Glue for Multimedia on the Mac and the IBM PC

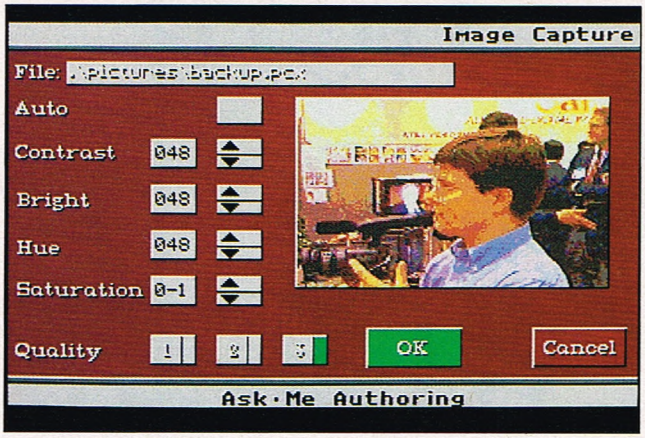
Two new programs help you combine video with sound, graphics, and animation. One runs on the IBM PC, the other on the Mac.

A new version of Ask*Me—a program that integrates animation, voice, sound, graphics, and images into multimedia presentations—supports PCX image separation and manipulation and the ability to pan across images larger than your screen.

With Ask*Me 2000 and its English-like programming language called Stratos, you can combine images from Autodesk Animator, video capture boards, PCX-compatible paint programs, and bit-mapped font packages that are in the GEM format with voice and sound to create interactive presentations. The program also supports looping, for canned, repetitive presentations. While the program includes Stratos, no programming experience is needed to create most applications.

Ask*Me uses its own graphical user interface and comes in two versions: Ask*Me 2000, for the casual user, and Ask*Me Professional. The professional version includes a multiuser customizable image database that can open up to 256 files at once and supports full-motion video. This version also has an optional Display program for distributing run-time presentations. Run-time capability is standard with Ask*Me 2000.

Ask*Me requires at least a 286 with a 28-ms or faster hard disk drive, 7 MB of free hard disk space, 640K bytes of RAM, and VGA graphics.
Price: $495 for regular version; $1795 for professional version; $195 for professional run-time license.
Contact: Ask*Me Information Center, a division of Innovative Communication Systems, 2534 26 Ave. S, Fargo, ND 58103, (701) 293-1004.
Inquiry 1286.



*Once you've captured a photo with Ask*Me, you can manipulate image hue, contrast, and other attributes.*

Unlike MacroMind's Director, which is a tool for creating professional-quality animation on the Macintosh, the company's MediaMaker is for nontechnical people who want to create relatively simple video presentations.

MediaMaker is divided into two parts: collections and sequences. Collections are media databases, snippets of video, compact-disk audio, Mac audio, graphics, and animations. You play back the media selections by double-clicking on a picon, MacroMind's term for a visual cue of an image.

To create video presentations, you drag picons from the collection window to the sequence window, arranging and rearranging the media in desired order and editing the length of each clip. You can also synchronize other media such as CD audio and graphics. To use the program, it's best if you can tap into existing video libraries, the company says.

To use MediaMaker, you should have a Macintosh with support for color, a videodisk player, CD-ROM audio, a digitizing board, and a videotape recorder. A color Mac is not required.
Price: $495.
Contact: MacroMind, Inc., 410 Townsend St., Suite 408, San Francisco, CA 94107, (415) 442-0200.
Inquiry 1287.

Hand Recognition for Windows and the Mac

Datacap, developer of the Paper Keyboard handwriting recognition program for the Macintosh, now has a version for Microsoft Windows 3.0 that reads handwritten characters on paper forms directly from an off-the-shelf scanner. It recognizes names, addresses, dates, numbers, and multiple-choice check boxes without having to convert written characters to typed or printed text.

Datacap says that Paper Keyboard encounters, on the average, one character out of every 20 that it can't identify. When that happens, the correction portion of the program kicks in. With corrections, the program recognizes about 20 to 25 characters a second. Paper Keyboard also supports automated verification.

Datacap claims 99.9 percent accuracy with a target confidence of 9 (you can choose target-confidence levels from a scale of 1 to 10).

On the Mac or IBM PC with Windows 3.0, the program requires 2 MB of RAM, a hard disk drive, and a forms layout package. You also need an optical scanner.
Price: $895.
Contact: Datacap, Inc., 5 West Main St., Elmsford, NY 10523, (914) 347-7133.
Inquiry 1288.

Protect Your Unix Data from Power Loss

With their complex file structures and file buffering mechanisms, Xenix and Unix systems are susceptible to data loss when power is removed from the computer before it can write the buffers to disk. A program called PowerMon monitors signals from your UPS and, when it detects a power loss, issues messages to users that the system may have to shut down if power isn't restored. If the power does not return within a certain number of minutes, PowerMon flushes everything in the system's buffers to disk, preventing data loss.

PowerMon runs on SCO Unix, SCO Xenix, and Unix systems from Sun, DEC, and IBM.
Price: $149.
Contact: Systems Enhancement Corp., 761 Spirit of St. Louis Blvd., Chesterfield, MO 63005, (314) 532-2855.
Inquiry 1289.



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MULTIMEDIA VIDEO

When Jerry combines computers, video cameras, and VCRs, seeing is believing

All of us in the computer business get used to two kinds of video. On the one hand, there is the full-motion video you see on your TV. This is known as NTSC, for reasons that don't matter. What does matter is that it is quite low-resolution compared to what you see on your computer screen. It has to be, because if it were high-resolution, the full motion would be a great deal more complicated. Full motion, after all, requires on the order of 30 frames a second if it's not to look jerky (some older newsreels, as well as some of the first pictures taken in space during the Mercury/Gemini days, use a lower frame rate, which is why they *do* look jerky).

A VGA screen has a higher resolution, but that's also why it's tough to do full-motion video out of a PC: the amount of information that would have to flow at that resolution at 30 frames per second would swamp the system.

Genlock, Anyone?

On the other hand, a PCompatible is perfectly capable of displaying NTSC output, if there is some way to get TV video into the system: which is where genlock boards come in. These boards accept video input, mix it with what comes out of computer programs, and display the mixture on-screen. They will also pipe that mixed signal out to a VCR so that you can record it. (You can't record that live-action video on your hard disk because it wouldn't hold more than a minute or so; live-action video recordings use a *lot* of megabytes. And yes, there are some tricks involving video compression, but that's not important here.)

This is important to us because Mrs. Pournelle's Reading Program needs some good promotional materials. We figured the best way to do that was to make videotapes; alas, the problem was, how do you videotape the output of a computer? You sure can't just use a video camera on the screen, as Roberta found; at least, you can't just use *our* video camera. The results are awful.

We thought of using an Amiga, which knows how to put out NTSC output, but I wrote the program in Microsoft QuickBASIC, and it is not easily ported to the Amiga.

Then I discovered the USVideo TVGA Video Board at a BYTE Editorial Expo. It looked to be the answer to our prayers: this is a PC board that accepts video camera or other TV input, mixes that with what's on the screen, and puts the combination out for recording by a VCR. Not only that: you can also mix in the output of Autodesk Animator, which is a program that, if you have artistic talent or can hire someone who does, will produce results best described as amazing.

Want fairies to dance on your screen? Perhaps a screen background of program output, with fairies to illustrate your point? Birds in full color? Really weird titles? You can get it all from Animator. In a word, the USVideo board and Animator seemed the perfect combination for presenting Roberta's program.

About that time, we discovered Willow Peripherals. Willow also makes a Genlock Video Board. Moreover, our copy came with Entropy Engineering's Video Titler, which will make all sorts and conditions of high-resolution titles and screen effects that can be mixed in with other PC output and stored on videotape. Now we really had everything we needed.

Thus, when Larry Aldridge of Sterling Microsystems brought over the Cheetah Gold 486, we tried to install one of the genlock boards. There was only one problem: we didn't have a monitor of poor-enough quality.

That is, the monitors that we had available at the time included my Zenith Flat Technology Monitor, which I use every day and which is about the best text-work monitor I know of; the 19-inch Electrohome monitor, which I have had nearly forever and which everyone loves; and a very high-resolution 19-inch Hitachi monitor primarily used for CAD. None would work properly: they just don't go down low enough in frequency to display NTSC output. Sigh.

I have, somewhere around here, a converter for the Electrohome monitor that will let it eat NTSC output, but it would have been a great deal of trouble to get it out and connect it up, and besides, we were anxious to get the Cheetah 486 running with a Sota VGA board and look at some really high-resolution CAD and Animator work, which looks terrific on the Hitachi monitor. Thus, I put both genlock boards away for another time.

A few weeks later, Alex and his roommate tried to get things running on a Gateway 2000 system, but they had the same problem: both genlock boards want a multifrequency monitor, and we didn't have one. Meanwhile, at Spring Comdex Roberta had been mightily impressed by the USVideo demonstration and was now anxious to get started.

Of course, it never rains but it pours. Two days later there arrived two multifrequency, auto-sync monitors. One was from Princeton Graphic Systems: I'd met Princeton's president Tom Anderson at Spring Comdex and told him my story, and he'd arranged for an Ultra-14 to be sent. I knew those worked, because that is what came with the Northgate system I reviewed last year. The other monitor was a Panasonic PanaSync C1391, which was recommended by Willow as a good one for use with their board.

After that, things were simple: using the Gateway 2000 (a good, solid, reliable

machine) as the basic engine, we installed both the Willow and the USVideo boards, connecting them to the VCR/TV I keep in the back room up here. Both boards work with both monitors. The images on both monitors are rock solid. Alex and I set up the Willow board with Video Titler and turned things over to Roberta—and the adventures began.

Both Willow and USVideo advertise their products as if reasonably knowledgeable people who aren't computer experts can use them. We make no doubt at all that this is true, but it's not simple. It's going to take time. As Roberta says, before you can genlock, you have to understand what genlocking is all about; and you only think you know that.

First came the Willow manual: she reports that in 12 pages of text, there was not *one single sentence* that she understood. Part of it is the terminology, but some of it is the English: she's not at all sure some of the sentences actually say what Willow thinks they say. The USVideo manual wasn't a lot better.

On the other hand, both companies have very good telephone technical support. "They both put up with my stupid questions," is the way Roberta put it. My guess is that they have no choice, since these products are going to find their way to art departments and account executives, creative people with little computer experience, who will desperately need the output—genlock stuff can be *spectacular*—and they will have less experience than Roberta, who has, after all, lived in Chaos Manor during the entire computer revolution.

With both genlock boards, you cannot easily mix monochrome and color.

Technically, both boards work, except that you cannot easily mix monochrome and color: Roberta describes that as similar to what happens when you watch oil and water mix, and it seems to be the same with both boards. Neither one is easier or harder to use: they're both simple enough to set up once you have the right monitor, and both are equally confounding when it comes to making the software do what you want it to.

I wish I were more of an expert on this subject, because it's important; maybe I can trigger BYTE's expert test crew to do a complete evaluation, because I'm really not competent to tell you which is the best product in this line. I can tell you why it's important, and that we have two systems that are state of the art.

And there, alas, matters stand. Roberta has done the beginnings of some work. I've seen it, and it's already pretty good. Not spectacular, but she's only getting started. I'm sure I'll have more to say on this next month.

Rogers Specialist

When it came time to hook up a monitor to the Willow board, we needed a gizmo to convert a 9-pin video into a 15-pin video. We put on our safari outfits and made an expedition into the cable room, and there among the monsters we found the cable we needed, but there was a gender problem, so we searched some more.

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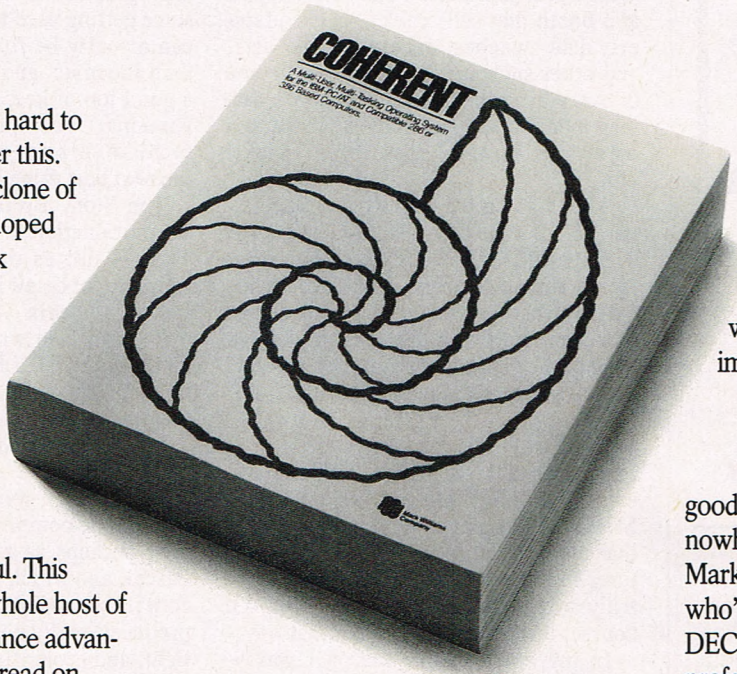
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Price	$99.95	$1495.00

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Hardware requirements: 1.2 meg 5¼" or 1.4 meg 3½" floppy, and hard disk. SCSI device driver available soon. Does not run on Microchannel machines.

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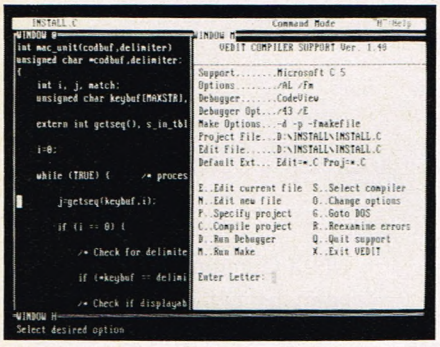
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"Aha," Alex said. "The very thing."

He hauled out a large bag of cable adapters, gender changers, 9-pin to 25-pin converters, and other such stuff. It took me a moment to remember where I'd got it: just as we were leaving the last West Coast Computer Faire, I'd stopped at a booth that sells cables, cable adapters, data switches, general small parts, and other such stuff, and grabbed some of everything in sight on the theory that they would come in handy. It came to a bit over $100, and I don't regret a nickel of it.

Alex noticed the bill: Rogers Specialist (27712 Pinehills, Santa Clarita, CA 91351, (805) 251-2520). "We order from them all the time," he said. "They deliver what they promise, no nonsense. Good outfit." This exhausts my knowledge of the firm, but I figure that when I can identify a good guy, I ought to.

Stony Brook Modula-2

I was an early enthusiast of Modula-2, even back in CP/M days; indeed, when Modula-2 first came out, I was confident that it would be the language of the future, replacing Pascal, C, and BASIC—truly a language for the rest of us. Of course, things didn't work out that way.

In my defense, one reason I was so pleased with Modula-2 was that I had an early Lilith, a machine that uses Modula-2 as its assembly language. Modula-2 in the Lilith environment was a programmer's dream: the machine kept track of versions, and libraries, and what had to be recompiled, and all the other details that make programming tedious. With Lilith, programming was *fun*, especially compared with the other machines available then. Alas, the Lilith didn't survive.

There have been many problems with Modula-2. Probably the biggest is that there haven't been any good, standard run-time libraries of I/O routines for PCompatibles and other machines. Although Logitech developed a really neat debugger, the Logitech compiler, while quite adequate, is only that. And the Logitech programming environment has never been described as fun. Other compilers had some good features, some bad. The Taylor compiler produces small and speedy code, but it's not easy to use.

Worse, Modula-2 has design flaws. Not just the traditional I/O problems that any Niklaus Wirth language seems to have, but some odd quirks, such as rigid enforcement of case sensitivity and odd variable-name syntax (`InOut` is not only legal, but mandatory, but `big_screen` would not be a legal variable name). All these difficulties can be overcome, but they're obstacles to learning and enjoying a language for which there never were any really good tutorial manuals.

I am happy to say that many of those problems are no longer relevant.

The Stony Brook compiler comes with a programming environment that takes some getting used to, but once learned, it can actually be *fun*. The editor is more than adequate, and the environment does a good job of keeping track of libraries, versions, recompilations needed, and suchlike. It's not a Lilith, but it's easily the next best thing I've seen.

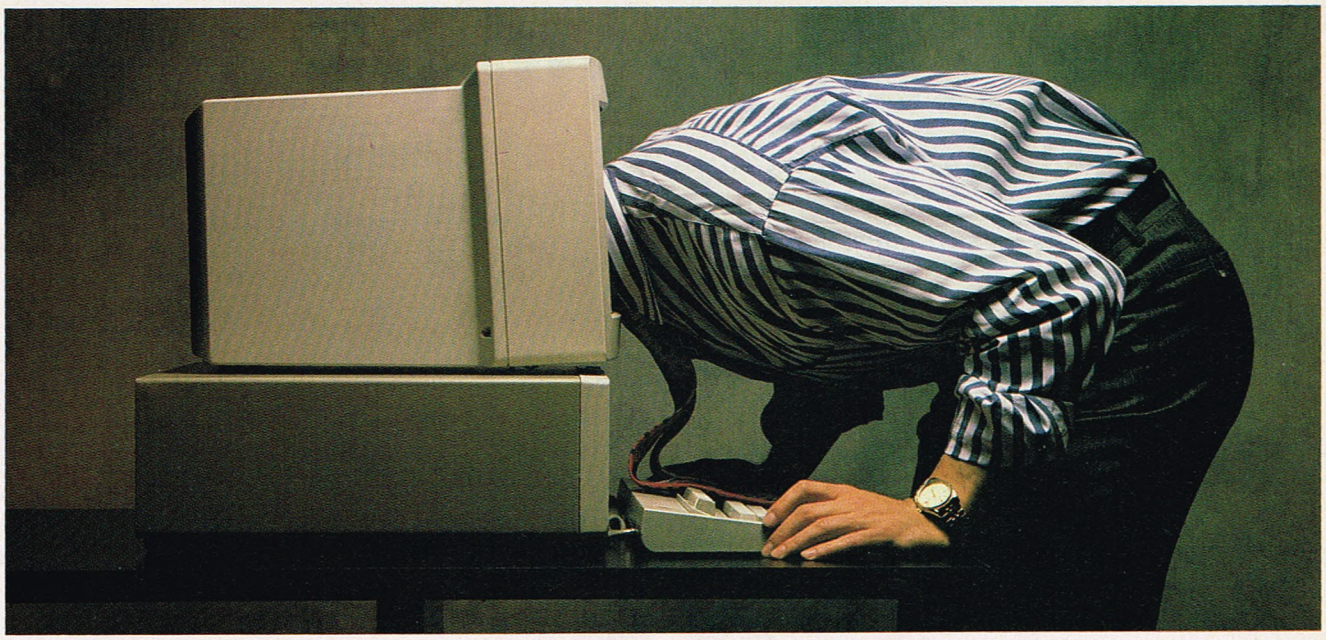
The Stony Brook documents include an introduction with lots of examples. They begin, as they should, by telling you in exact detail how to set up the environment, begin your library management, and then write, compile, and run PROGRAM HELLO. Then they move on systematically through the different features of the system.

Moreover, with the Professional package (will anyone *ever* admit that something might be good for amateurs?), you get not one compiler but two: one that is *fast*, perhaps as fast as Borland Turbo Pascal, and which produces darned good code; and an optimizing compiler that produces *really* good code—small, fast, tight, and generally neat. Code from this second compiler is Microsoft object code–compatible, meaning that you can link it up to compiled BASIC, C, Microsoft Pascal, or FORTRAN code. There are good instructions on how to do this.

The Stony Brook compiler can produce code you can debug with CodeView; Stony Brook also provides a good debugger of its own, along with a tutorial on how to use it in the environment.

The Stony Brook package comes with advertisements and coupons for other Modula-2 products, all compatible, including sorts, B-tree, and a decent I/O library. I'd like to see more of that sort of thing: what Modula-2 needs is a body of compatible libraries of programs and toolboxes easily available for all flavors of PCs, and particularly all keyboards and video boards. This is a good start.

Realistically, I suppose, Modula-2 has lost out in the language wars, and the likelihood that it will surge ahead to capture the place held by Pascal or C is low. I think that's a pity: in my judgment, Modula-2 is more powerful than Pascal (even Turbo Pascal) and incomparably easier to use than C. Modula-2 really shines when you have a large project to be worked on by a number of programmers: with Modula-2, you really can have the programmers get together to write Definition modules and then work



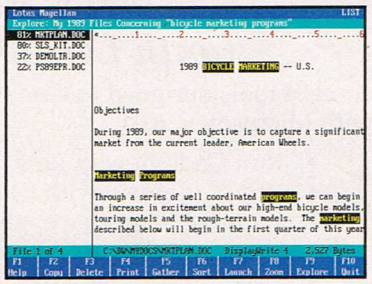
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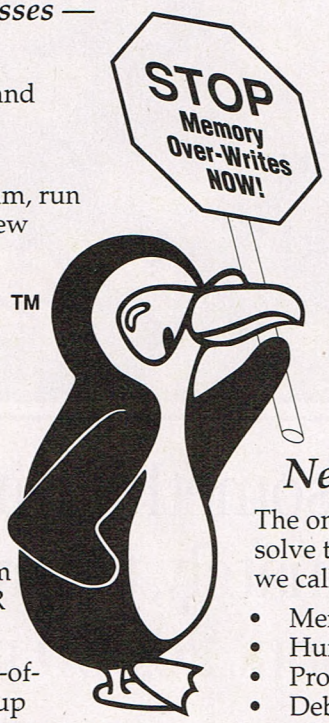
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apart on their implementation, yet have some hope that when they get back together, the code will run with no side effects. Of the other languages, only Ada can make that claim with any honesty.

This isn't meant to knock Turbo Pascal, which is a realistic choice for many programs. Borland provides excellent support for Turbo Pascal and continues to improve it and add features.

Then, too, I still like BASIC, and modern compiled BASICs have incorporated a number of advanced features derived from ALGOL, Pascal, and Modula-2. Given the on-again, off-again nature of the programming I do, I'll probably stay with QuickBASIC and the various Crescent tool libraries for most of my work; however, if I ever went more nearly full-time as a programmer, I do believe I'd adopt the Stony Brook Modula-2 environment, which has hooks to Windows and OS/2 (you'll still need the Windows and OS/2 development kits, understand).

If Stony Brook Modula-2 had existed in the early days, I think it would have the place that Turbo Pascal has now, and more. If you've ever wondered about Modula-2, or if you tried it and sort of liked it but gave it up, or if you're looking for a language, look at Stony Brook Modula-2. Recommended.

If Stony Brook Modula-2 had existed in the early days, I think it would have the place that Turbo Pascal has now.

[Editor's note: *See "Modula-3" on page 385.*]

Zero Surge

One of the participants in the sciences conference on BIX told a story of a meeting of meditation people at a European village near a lake. The guru in charge told the group to concentrate on the weather, which they duly changed to something wildly improbable; the next day, supposedly, they did it again, this time changing the weather a dozen times in the course of an afternoon and playing merry hob with the local tourists. As in all such stories, the guru isn't named, the group isn't named, the lake isn't named, and the date and year aren't specified. Moreover, the person telling the story wasn't there himself, but heard it from someone who was.

"Great," said I. "Tell you what. Get that guru to make it rain in Los Angeles on the afternoon of August 7, 1990. Specifically, rain in the Hollywood Hills."

I thought no more about it until on August 5 came a freak lightning storm and rain. Then more on the 6th, with a really spectacular show of lightning and thunder. Some of the lightning came quite close to Chaos Manor, with thunder less than a second after the flash. Alas, it didn't rain on the 7th, although there were showers on the 8th....

However, the lightning got me thinking about surge and spike suppressors.



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Regular readers may remember The Great Power Spike that hit Chaos Manor last year: light bulbs literally exploded, and the Priam MacDisk on the Mac II suffered a hit to the power supply, as did the Mac II itself, although both were plugged into a commercial surge suppressor. We also lost a Tandon computer, a TV and VCR, and some other electronic gear, none plugged into a suppressor; and we did not lose Roberta's machine, although its surge suppressor literally died in its defense.

Since then I have learned that a lot of surge suppressors do not work very well. The passive metal-oxide varistors (MOVs) may over time lose their capability, especially if subjected to power spikes. In addition, since most surge suppressors divert the power surge to ground, and most LAN and modem systems have one side of the signal system grounded, there can be power surges in the resulting "ground loop."

Note that I say "may" and "can be"; none of this is inevitable. Unfortunately, many people out there seem determined to convince you that it is: that if you use ordinary surge suppressors, you are playing Russian roulette, and you'll probably *lose your expensive computer equipment*, so you had better *replace those now*. Even an uninterruptible power supply (UPS) isn't going to save you, because, as one article I have here says, "their inputs are 'protected' by the very same fifteen-cent MOVs as the average surge suppressor!" There is, according to this, only one exception to this, Abacus Controls, which licenses their technology from Zero Surge.

And this leaves me with a dilemma. It's certainly true that the Zero Surge protection systems are excellent, better than the stuff you buy at Radio Shack or at swap meets; it's true that shunting power spikes to ground *can* blow up a modem. It's true that UPS systems often rely on MOVs. It's true that MOVs can die and you won't know it, because doing a nondestructive test on an MOV requires extremely sophisticated (and expensive) test gear.

It's also true that in The Great Power Spike at Chaos Manor when, due to an automobile accident, 16,000 volts AC was shunted into our house wiring, not only was there no damage to the computers connected to our Clary UPS, but there was absolutely no damage to the UPS—we had it tested. Moreover, of the equipment connected to the off-the-shelf surge suppressors we use, the only thing killed was the Mac stuff, which had been connected to a different—premium!—brand. Everything else was fine.

So: yes, the Zero Surge suppressors are qualitatively different, and better, than the usual device. They don't shunt power spikes to ground, they work faster, and they don't deteriorate. You will certainly be safer with Zero Surge than with a random MOV device. I sincerely doubt that you'll be safer with Zero Surge than with a Clary UPS, or let me put it another way, I sure don't want to *have* to be protected from anything worse than our Great Power Spike. However, if you have LANs and modems and generally interconnected devices not all connected to UPS systems, you probably do want to look into Zero Surge.

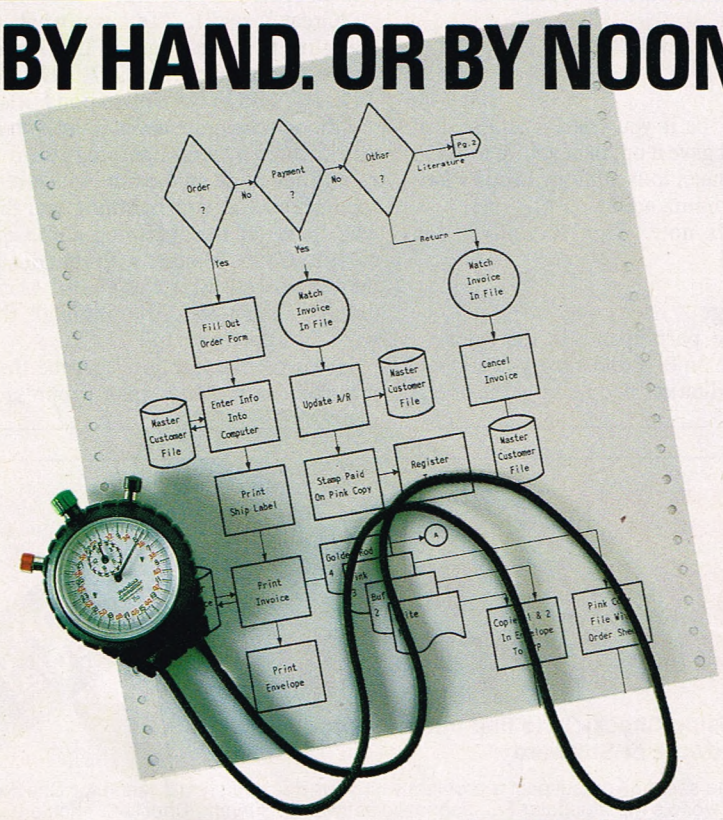
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I love gadgets. I don't usually have a chance to write about them, but this is November and Christmas is coming up. Perfect time.

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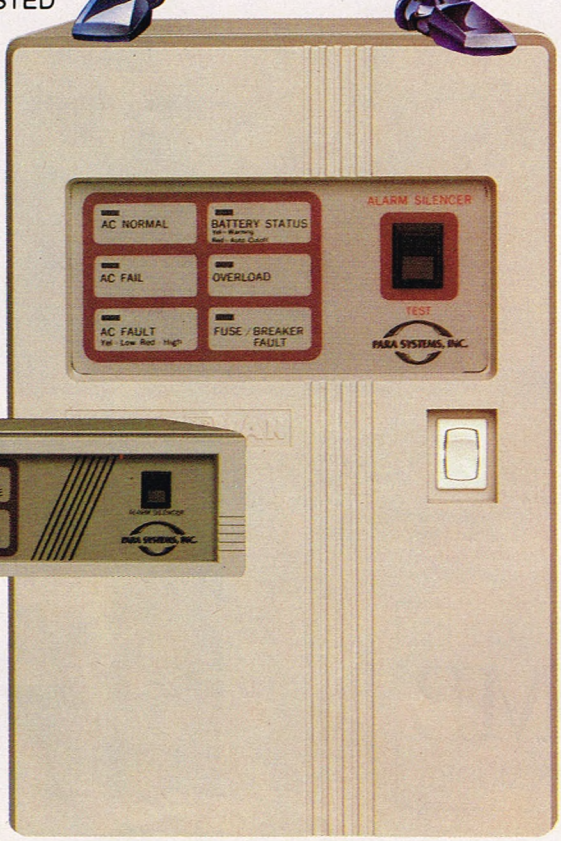
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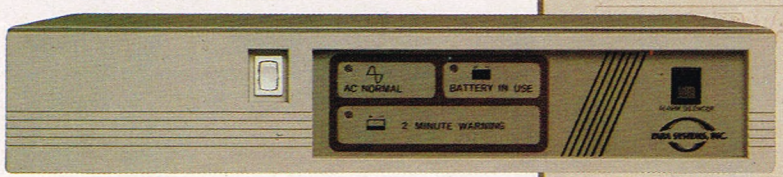
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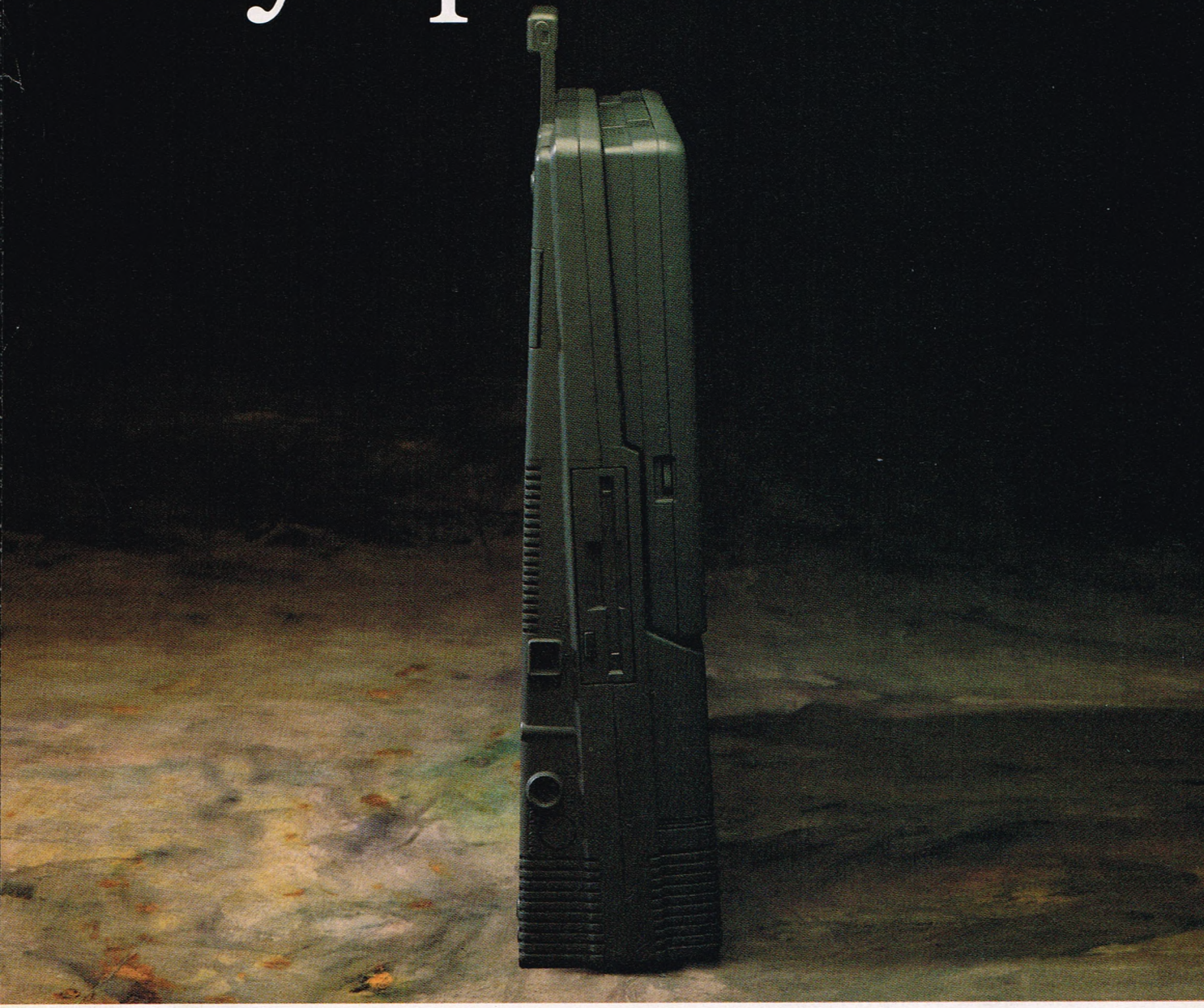
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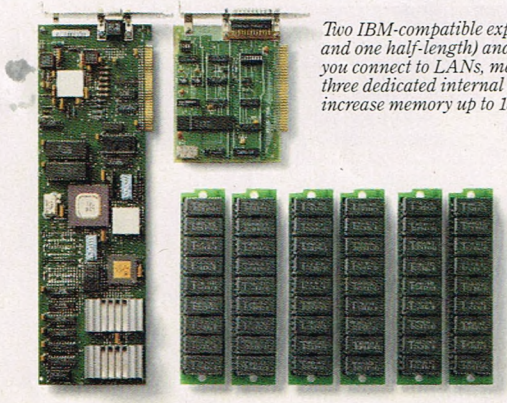
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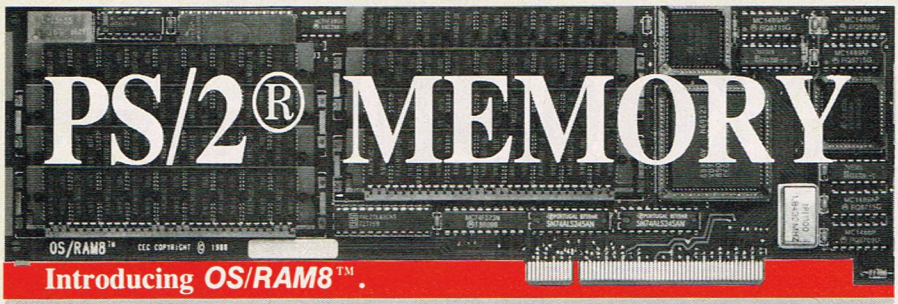
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the Amazon Binary Clock, which is not cheap, but nothing in the house attracts more attention. It looks like a golden-mean dimensioned rectangular block of black plastic about 8 inches tall. There are three columns of six lights: left column for hours, middle for minutes, and right for seconds. They give the time in binary, which is to say: the bottom row is 1, row two is 2, row three is 4, up to row six for 32; to get a number, add all lights that are on. Thus, if 1, 3, and 4 in a column are on, the number would be 13. All 18 lights flash once per second and then settle into the current time.

Time can be displayed in a 12- or 24-hour format. Depending on which setting you choose, the top one or two rows of hour lights are superfluous. It will take either 50- or 60-cycle current; it comes set to 50-cycle, which gives the wrong time over here, but it's easy to change.

The instructions are complete and foolproof, and actually, after a few weeks, you learn to read it fairly well, or at least I did. This isn't something anyone needs, but if you're into unusual things for your mantle or coffee table, this will do it. I have it on a living room display table with my collection of archaeology artifacts: somehow, it seemed in good company with an ancient Roman (obscene) oil lamp. And it keeps good time, too.

Go!

I don't keep track of computer go tournaments, so I don't recall whether COSMO or Bruce Wilcox's Nemesis-Go master version from Toyogo is the current champion, but one of them is, much to the vexation of the Japanese go programmers. Go is the Japanese national game; it's played on a board of 19 by 19 lines, the rules are extremely simple, and the strategy is much more complex than chess.

I long ago became fond of Nemesis-Go for the Mac and PC, so much so that I have the PC version on my Zenith Z-386 laptop portable, in case I get stuck in an airport lounge with nothing to do. (Fat chance; there's *always* a deadline, so I end up writing. Oh, well.) Now, though, there's another way to have go with you wherever you are: Toyogo has a dedicated go-playing hand-held machine that is called Nemesis Igo Dojo.

It plays excellent go—unless I give myself a handicap, it will usually beat me—and it's well designed, with a good user interface. The screen is easy to see, and the controls are easy to use. There are bays to plug in additional modules (not yet available). I had some trouble figuring out what the controls do—some of it isn't obvious—but straightening that out only took reading the manual, maybe 10 minutes of work, after which it's quite intuitive.

Nemesis Igo Dojo plays by both Chinese and Japanese rules. In Chinese rules, the handicap stones may be placed anywhere; the stronger player passes until the weaker has placed handicap stones where he wants them. In Japanese rules, the handicap stones go on fixed points. In addition to handicaps, there are levels of play, although the book doesn't recommend that you use the weaker ones; as Wilcox says, you won't become a strong player by watching weak play. Use the handicap system if the machine continues to beat you.

The only real defect, so far as I can tell, is the size: at 9 by 5 by 1½ inches, it is considerably larger than a Sharp Wizard, larger even than the Atari Portfolio. You won't carry this in your pocket, or even in a gentleman's shoulder bag; you'll want a briefcase or small backpack.

What more can I say? The Nemesis Igo Dojo works, works well, and is just the thing for a go fanatic or someone who wants to become one. It's made in the U.S., and many are exported to Japan. And, of course, if you just want a strong go opponent for your computer, there are PC and Mac versions of the program itself. Recommended.

Scene Generator

This doesn't quite qualify as a gadget, but there are similarities.

Graphics capabilities on the PC have pretty well caught up with the Mac and Amiga, although you'll spend a bit doing it. Even so, every now and then there's a program unique to the Amiga. This is one of them: if there's anything like it for the Mac or PC, I haven't seen it.

Nature loves fractals, curves of infinite complexity that have the property of being similar no matter what level of detail you go down to. Case in point: coastlines, seen from orbit, are irregular. Get closer, and they still are. Get down to resolution in feet, and they still are; and even down to grains of sand, there are still these irregularities, similar although not identical to what you saw from orbit.

Scene Generator uses this property of nature to generate scenery. Some years ago, the designers of the game Starflight used a similar technique to generate the scenery for the thousands of planetary areas you could explore, but the scenes they generated weren't nearly as realistic as the ones Scene Generator comes up with; indeed, some of Scene Generator's fractally generated random scenes are nearly indistinguishable from scanned-in photographs taken in the High Sierra,

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and others would convince you they were from the moon.

There are six resolutions. The program gives you a great deal of control over what you generate—how much water, snow, greenery, clouds, and suchlike. I can't think of much practical use for this program except to generate eye candy, although you might use it when building a game; but it's fun to play about with. If you have an Amiga, this is likely to be interesting.

Disney Animation

As long as we are talking about the Amiga, Walt Disney Software presents a paint and animation program, The Animation Studio, in which Mickey Mouse and Donald Duck teach you how to do animated drawings; for my money, it's the easiest such program I've seen. I was about to push the Amiga into another room, but now I have second thoughts: this thing might even make *me* an artist, and that would take some doing.

I was recently back at Douglas Trumbull's Berkshire Studios, where we had a meeting about Klaus Heiss's Mars Cup, to be awarded for racing a solar sail vehicle from Earth to Mars; there's some hope actually to get that started as part of the 500th anniversary of the first voyage of Columbus. One of Klaus's demonstrations was a videotape of some solar sail models and their deployment; this was done by some Georgetown University students using an Amiga and Degas Paint. It would have been even easier to do with The Animation Studio.

Every time I think the Amiga is about finished, someone comes up with new and unique products for it. As long as Amiga has friends like Disney's programmers, you can't count it out. This program is good—and it's *fun*.

Multi-Media Birds

CMC Research continues to refine their DiscPassage CD-ROM retrieval software. Now there are help files, and the video imaging works with just about every major video card, including those from Tseng Laboratories, Video Seven, and Tecmar. The help routines aren't always as helpful as they think, and there's a harshness to some of the retrieval interface that wasn't there on their first Sherlock Holmes disk; on the other hand, it does the job, and once you're used to the interface, it works on a whole raft of CD-ROM disks.

CMC's lineup includes a number of medical books and journals, and I'd advise any physician to look into them: you may find that what you want is on a CD-ROM, meaning that it is nicely organized, with search and retrieval capabilities superior to the best paper indexes.

Their latest CD-ROM is Multi-Media Birds of America, which consists of the complete John James Audubon *Birds of America* lithographs. There are also recordings of bird calls and the Audubon text.

The bird calls, which are pretty nice, are what justify calling this "multimedia." There's no animation, the text itself is pretty dry, and, worse, it was all written a long time ago and could use some modern commentary.

Example: there are families of red-tailed hawks in the hills above our house, and we go up to visit them quite often; so naturally I looked up red-tailed and hawk in the search pattern, to find that this bird is not known as a red-tailed hawk, but Harlan's buzzard. There's no entry at all for the peregrine falcon. Now, I'm no expert, and it may well be that the real experts call a California red-tailed hawk "Harlan's buzzard" and have some esoteric name for peregrine falcons making them impossible to find; but Peterson's *Field Guide to Hawks* sees it quite differently, as do all the other bird books we have.

I had similar problems looking up the goatsucker: from this CD-ROM, you may or may not be able to find out that the whippoorwill and the common nighthawk are members of the goatsucker family, but I didn't.

In other words, this is J. J. Audubon's book and nothing else; for the practical bird watcher it's no substitute for the Peterson guides, which, alas, have yet to be put onto a CD-ROM. On the other hand, the 500 Audubon paintings are magnificent, they show up beautifully on a VGA screen, the bird calls are interesting, and the retrieval software works fine: if the information is on the disk, DiscPassage will find it. You don't buy this for the text, though.

Grolier Again

It is my practice to send the text of my column to the company or people affected, with a notation that I'll correct errors of fact, I'll listen to arguments concerning errors of judgment, and I reserve the right to determine which is which. I did that with the Grolier text last month; alas, they took a very long time to respond, so that by the time they did, the column was set in galley. When an author rewrites in galley, it is very tough on the composition and layout crew; and after some thought, I corrected the things easily done and let the rest stand.

Herewith, then, not quite a retraction.

First, Grolier is reconsidering their license policy, in part due to my nagging

ITEMS DISCUSSED

Amazon Binary Clock.....$150
Eugene Amazon
13, Rue de la Madelaine
1204 Geneva, Switzerland
022-21-18-96
Inquiry 1146.

Autodesk Animator.....$395
Autodesk, Inc.
2320 Marinship Way
Sausalito, CA 94965
(800) 525-2763
(415) 332-2344
Inquiry 1147.

Genlock Video Board
with 512K bytes of RAM and
Video Titler program.....$895
Willow Peripherals, Inc.
190 Willow Ave.
Bronx, NY 10454
(800) 444-1585
(212) 402-0010
Inquiry 1148.

Grolier Encyclopedia Americana.....$399
Grolier Electronic Publishing, Inc.
Sherman Tpk.
Danbury, CT 06816
(203) 797-3500
Inquiry 1149.

Modula-2 Professional for DOS and OS/2.....$295
Stony Brook Software
187 East Wilbur Rd., Suite 9
Thousand Oaks, CA 91360
(800) 624-7487
(805) 496-5837
Inquiry 1150.

Multi-Media Birds of America.... $99
CMC Research, Inc.
7150 Southwest Hampton St.,
Suite C120
Portland, OR 97223
(800) 262-7668
(503) 639-3395
Inquiry 1151.

Nemesis-Go..... $79
Nemesis Igo Dojo.....$695
Toyogo, Inc.
P.O. Box F, Dept. Y
Kaneohe, HI 96744
(800) 869-6469
(808) 254-1166
Inquiry 1152.

PanaSync C1391.....$899
Panasonic Communications &
Systems Co.
Office Automation Group
2 Panasonic Way
Seacaucus, NJ 07094
(800) 742-8086
(201) 348-7000
Inquiry 1153.

Scene Generator..... $49.95
Natural Graphics
P.O. Box 1963
Rocklin, CA 95677
(916) 624-1436
Inquiry 1154.

Surge Eliminators.....$149 and $199
Zero Surge, Inc.
103 Claremont Rd.
Bernardsville, NJ 07924
(201) 766-4220
Inquiry 1155.

The Animation Studio.....$179.95
Walt Disney Software
500 South Buena Vista St.
Burbank, CA 91521
(818) 567-5340
Inquiry 1156.

TVGA Video Board.....$799
Genlock Overlay Module.....$399
USVideo
62 Southfield Ave.
One Stamford Landing
Stamford, CT 06902
(203) 964-9000
Inquiry 1157.

Ultra-14.....$899
Princeton Graphic Systems
1100 Northmeadow Pkwy., Suite 150
P.O. Box 100040
Roswell, GA 30076
(800) 221-1490
(404) 664-1010
Inquiry 1158.

Video Titler EGA and VGA.....$495
Entropy Engineering
12317 Village Square Terrace,
Suite 202
Rockville, MD 20852
(301) 770-6886
Inquiry 1159.

them. They were concerned that if they routinely released the "network version" of their CD-ROM retrieval software, they would have dozens of people using one CD-ROM. I asked how many establishments there are in the U.S. where that's likely. Or even possible. Could there be more than 20?

And of course there are not, meaning that they're inconveniencing thousands of users in order to prevent the possibility (hardly a certainty) of being ripped off by a couple of dozen customers at most. That's assuming that Grolier is being ripped off if several people on a network access a single CD-ROM in rapid succession. They can't, after all, access it simultaneously, because the laser can't be in more than one place at once—and in any event, how is it worse than when several people use different volumes of the printed encyclopedia?

So: as I said, Grolier is reconsidering that policy. At the moment, though, what I said is true: if you have a network card in your machine, even if it is not enabled, you'll have to get the network version of the Grolier retrieval software. They say they are willing to send the network version free to anyone willing to sign a statement that it won't be used by more than one person at a time.

Second, if you have multiple CD-ROM drives, you must invoke the Grolier retrieval software as `EE -d0` or `EE -d1`, depending on which one of your drives you have the CD-ROM in. Don't bother looking for that in the manual: it's not there. There are apparently further undocumented features in the software. In addition, if you use the Install program on the distribution floppy disk, it does not copy over all the files, and thus you will be unable to reconfigure unless you have the original disk; however, you can manually do a COPY *.*, which will bring over all the files; the disk isn't really copy-protected. That, too, is not in the manual.

Someone in the Grolier hierarchy decided that explaining all this stuff would confuse the user. I am told that this policy has now been abandoned and there will be a new appendix to the manual explaining the switches and other undocumented features, to which I can only say, hurrah.

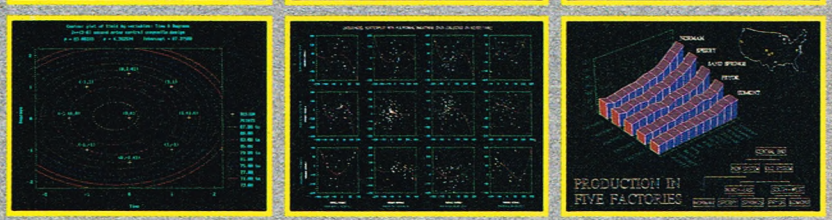
I am becoming increasingly fond of the Grolier Encyclopedia Americana itself, and once you get used to it, the

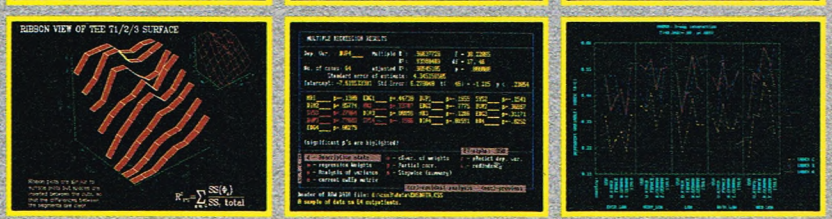
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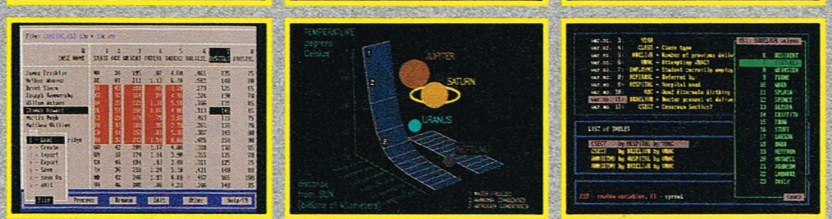


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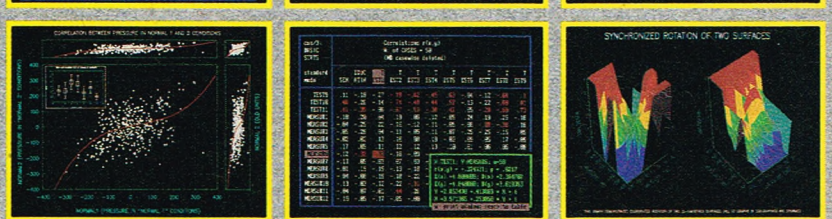


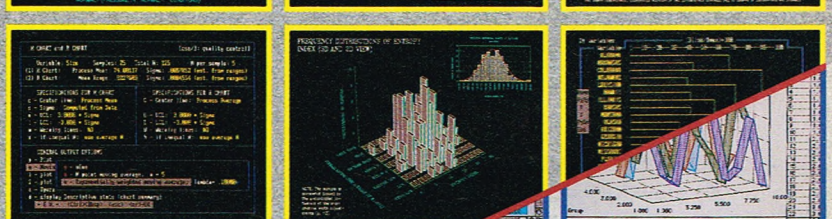




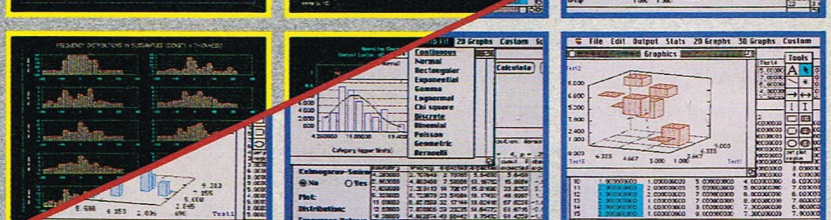
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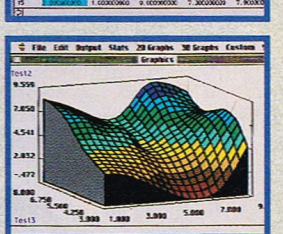
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retrieval software is easy both to remember and to use. I'm pleased to see that the company is reevaluating its licensing policies to make life easier for their customers. I wish more companies would.

Winding Down

Again, my desk is piled high with stuff I won't get to. The Sola Publishing Group (Via Nerino, 8-20123 Milan, Italy) sent me a CD-ROM labeled "An unabashed history of photographic erotica" that isn't precisely what the title says: most of the pictures would be better described as "raunchy" than erotic. About half the text is in Italian.

There are two Mannesmann Tally printers. One is their MT 906 laser printer, which uses the Microsoft/Bauer interpreter and Bitstream fonts to print PostScript files. It also emulates the Hewlett-Packard LaserJet II and comes with the Z print cartridge, my favorite for my old LaserJet I, the Printer That Will Not Die. We are in the middle of torture-testing the MT 906 with some complex PostScript files that I got from Dave Moore and Trevor Marshall; if it prints those files properly, it should print anything. It's sure fast.

I also have the MT 81, a really neat dot-matrix printer that's small enough to become the "throw it in the Bronco" printer for field use. It came in a sturdy box that I have reinforced and practically waterproofed with duct tape.

The bribe of the month is a wonderful Victorian inkwell, from Underware, in celebration of the company being bought out. The game of the month is still Railroad Tycoon, although the Strategic Studies Group does have some nifty new scenarios for their World War II simulation system—and the first decent Austro-Prussian war game I know of. The latter is a scenario for their Decisive Battles of the Civil War.

The books of the month are Jacques Barzun's *The Culture We Deserve* (Wesleyan University Press, 1989), typical Barzun, delicious and informative; and *In Pursuit of Truth: Essays on the Philosophy of Karl Popper on the Occasion of His 80th Birthday*, edited by Paul Levinson (Humanities Press, 1982). I became a convert to Karl Popper's theory of "falsification" as the only route to truth many years ago, and I'm ashamed of having missed this book on its publication. It contains a good introduction to and appreciation of Karl Popper's work, although anyone seriously interested in the philosophy of science would do well to read Sir Karl Popper himself: his *Open Society and Its Enemies* (Princeton University Press, 1966) is thoroughly readable, and his other works aren't really obscure.

I have the production copy of DR DOS 5.0, and next week I am going to a seminar on the new Desqview; next month I'll cover those, and, with luck, much, much more. ■

Jerry Pournelle holds a doctorate in psychology and is a science fiction writer who also earns a comfortable living writing about computers present and future. Jerry welcomes readers' comments and opinions. Send a self-addressed, stamped envelope to Jerry Pournelle, c/o BYTE, One Phoenix Mill Lane, Peterborough, NH 03458. Please put your address on the letter as well as on the envelope. Due to the high volume of letters, Jerry cannot guarantee a personal reply. You can also contact him on BIX as "jerryp."

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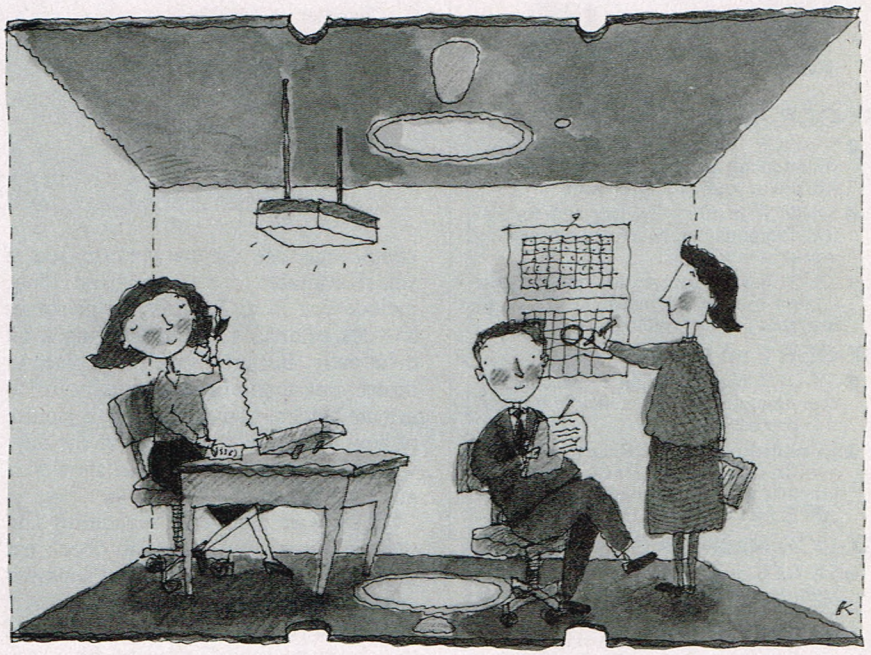
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THE GROWTH OF GROUPWARE

Don't buy more—or less—groupware functionality than you need



As LANs become more popular in business, the demand that they do something to support groups of people who work together becomes more important. The reason for this requirement is clear. In most organizations, people work in groups assigned to accomplish a task. These may be called project teams or departments, but either way, they are groups of people who work together.

Stand-alone software packages enhance a group's work only to the extent that they make an individual's work more productive. So, group productivity software, or *groupware*, was developed.

Last year I discussed two early groupware packages, WordPerfect Office and Higgins (see "Groping for Groupware," April 1989 BYTE). Since that time, groupware has become much more popular, there is a lot more of it, and there is a lot of variety in what it does to help a group be more productive.

The wider selection of groupware functions means that you have to look at what your organization needs in group productivity software before the company buys it. This variety is important, because, unlike with stand-alone applications, everyone must use groupware, so it must support everyone's needs.

On the other hand, there are reasons why vendors should not include unnecessary functions in a groupware package. For example, extra functions mean added complexity and more difficulty in learning how to use the package. Also because of this sophistication, it takes more to motivate people to use groupware once they have it available.

What Functions Do You Need?

Every groupware package includes E-mail, and nearly all of them include electronic appointment books and group scheduling. Beyond these features, the field is wide open. You will find packages that include everything from word processors and databases to calculators.

The key to determining which functions you really need is to look at how your workgroups work. Is communications their primary need? Do they have to schedule a lot of meetings? Are they working on creating reports and documents that have to get passed around a lot? Are group members confident computer users, or do they need to work from some kind of menu shell? Is the network limited to IBM PCs and clones, or are there Macs and VAXes in the mix? Before you start looking at groupware, you need to have answers to these questions, and you need to know a lot about how your LAN is used and how it's set up.

What's Available?

Of course, before you know whether or not you need any software, you should know what features and functions it offers. For example, you need to know that, with some packages, it is possible to schedule resources such as meeting rooms and slide projectors, along with the people who need to use them. You also might find that your organization is paying for features that it doesn't need and won't use, and that make the rest of the package harder to use.

As I mentioned, all these packages let you send E-mail messages across the network to other users. To use E-mail or be notified of new messages, users must log onto the file server containing the groupware package.

Likewise, most groupware packages contain some form of appointment calendar that can interface with a group scheduling package. You can keep your appointments on the computer, and other

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(25 to 125 users)
cc:Mail, Inc.
2141 Landings Dr., Building T
Mountain View, CA 94043
(415) 961-8800
Inquiry 1221.

INTO..... $1499–$3899
(five to 25 users)
Benchmark Associates, Inc.
7400 West Detroit St.
Chandler, AZ 85226
(602) 961-7519
Inquiry 1222.

Network Scheduler ..... $495–$995
(eight to 50 users)
cc:Mail Link.....$695–$1195
(eight to 50 users)
3+Mail Link .....$695–$1195
(eight to 50 users)
PowerCore, Inc.
P.O. Box 756
Manteno, IL 60950
(815) 468-3737
Inquiry 1223.

Office Works LAN ....$195–$1995
(one to unlimited users)
Data Access Corp.
14000 Southwest 119th Ave.
Miami, FL 33186
(305) 238-0012
Inquiry 1224.

people can use the network to see if you're available for a meeting and, if so, include you in it. Each of the packages handles calendars and scheduling a bit differently. But most give you a place to insert your appointments, usually in 15-minute blocks. You can also get a picture of how your calendar looks for the day, week, and month. Some will show six- and nine-month blocks of time.

If you want more than scheduling and mail features, you'll need to check out groupware packages with more sophisticated capabilities. Office Works LAN from Data Access, for example, includes the ability to send E-mail to other systems using telex and fax. Its mail system also supports specialized phone messages—electronic versions of the little pink messages that build up on your desk—and it can dial the phone for you while you're looking at the message.

Office Works includes the ability to track people and documents as well as mail. You can store names and addresses and use the information to print everything from mailing labels to Rolodex cards. This package also contains a control function that lets you track the location and contents of a document. If the document isn't in electronic form, the process is very difficult. If it is, the process is easy. Office Works LAN will start up the word processor that created the document and then load in the document for you to read.

You Want More?

Some managers want a complete groupware solution so that everyone will be using the same software for everything they do. To meet this requirement, they must have either a standard suite of network applications along with their groupware, or a groupware package that supports just about all the features that they are likely to want. There are packages that provide this type of functionality.

One such package is INTO (Intuitive Network Total Office) from Benchmark Associates. It attempts to support all the common office functions. In addition to E-mail and scheduling, you also get a phone book, a data manager, phone messaging, and a note taker (a kind of text editor with a search capability). And there's more.

At the point where other packages run out of features, INTO begins. Along with all the typical groupware capabilities, INTO includes a full-featured word processor, a spreadsheet, business graphics, and a calculator. Overall, you may find that this combination of features saves you money and helps to integrate your groupware and applications more tightly.

Do-It-Yourself Groupware

While the massive integration of large groupware packages might fit the needs of some organizations, many others find that their requirements don't extend beyond E-mail and time management. Either their corporate practices don't lend themselves to the rigid format demanded by more structured systems, or the projects involved are too specialized for most generalized applications. What doesn't change is people's need to communicate, either by mail or in meetings. A groupware package that fills this need is all that many organizations require.

If you have modest needs, it makes sense to purchase in a modest fashion.

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Likewise, if your needs for word processing are already met by another application, such as the LAN version of WordPerfect or WordStar, why pay for word processing in a groupware package? In fact, why buy a package at all? Why not assemble the parts you need yourself?

A modular approach to groupware is still in its infancy, but the initial parts exist now. Many organizations are finding that with a combination of the highly regarded cc:Mail and Network Scheduler, you can take advantage of the best of two excellent products. The fact that Network Scheduler will integrate itself with cc:Mail makes the system even more attractive.

Both of these packages were designed to perform a single specific task. For that reason, cc:Mail is very well designed, runs on a variety of platforms, including the Mac and the VAX, and is very rich in functionality. Likewise, Network Scheduler is designed simply to schedule time and does not go overboard providing needless frills like calculators and address lists. You get a complete scheduling package that's flexible and easy to use.

With a do-it-yourself approach, you don't have to buy anything until you need it. You can get started with E-mail by buying cc:Mail and then add Network Scheduler later as you need it. Both packages are inexpensive ($695 for a 25-user LAN), making them cost-effective as well as performance favorites. While you may not think price is your highest priority, consider how much you'd have to pay for a really large LAN and the fee many vendors charge for each user.

Groping for Groupware

As you can see, if you want to use groupware, you have a lot of options. They range from a solution you can assemble yourself to one that attempts to combine all the software your workgroup is ever likely to need.

Each of the packages will do what it's supposed to do, and each works on most popular LANs. The critical factor when choosing any groupware package is the requirements that you need to meet. Buying groupware that greatly exceeds your needs is probably a waste of money. Buying groupware that doesn't meet your needs is wasteful and shortsighted.

How do you find out what your requirements for groupware really are? You talk to the group of people whose productivity you're trying to enhance. You analyze what they actually need to accomplish by asking them what they do now and what they would do if it were possible. Then you turn those needs into documented requirements and match the requirements against the functions that each groupware package supports. By this process, you can obtain software that actually increases your productivity.

Next month, more on this subject as I look at how the heavy hitters can help your group be more productive. ■

Wayne Rash Jr. is a contributing editor for BYTE and technical director of the Network Integration Group of American Management Systems, Inc. (Arlington, VA). He consults with the federal government on microcomputers and communications. You can contact him on BIX as "waynerash," or in the to.wayne conference.

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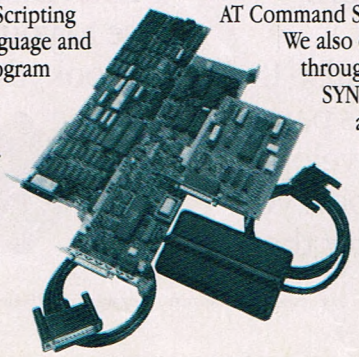
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HARD CHOICES FOR NETWORK MANAGERS



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Networks are practically unmanageable, and the situation is only getting worse. Unless vendors rally around a single network management standard, we'll all pay with more network downtime and more network problems in general.

The problem isn't that network management products don't exist. Quite the opposite is true; such products abound. The problem is that no single product addresses all the problems facing the managers of today's large, heterogeneous networks. Users need a single product with which to manage an entire network; what they have are different management products for every component.

It doesn't have to be that way. We recently got a tantalizing glimpse of what the future of network management could be. An administrator at a large institution was managing a network of over a thousand devices from a single Sun workstation. On the Sun's screen was a map of the network—little white boxes linked by glowing green lines. Each of the boxes represented a device, such as a workstation, bridge, router, or gateway. The lines indicated connections between the devices. Some of the connections were network media, such as Ethernet or fiber-optic cables, while others were T1 and microwave transmissions. When a device or connection encountered a problem, its on-screen counterpart turned yellow; when the device went down, its box or line glowed red.

You could even zoom in for a closer look. We double-clicked the mouse on a bridge, for example, and up popped statistics on the number of packets that bridge had received and transmitted, the number of errors, and so on.

We instantly knew what else the program could do. Clicking on a server's box would produce statistics on its file and printer usage. Clicking on an Ethernet cable would give us a closer look at the PCs hooked to that cable. Everything was in one place, accessible from this one program.

We were wrong. The program could not do what we wanted because the devices on the network didn't all support the same network management standard.

Back to the Future

Many of those devices, however, did support the Simple Network Management Protocol, and that support made possible the features we saw. The SNMP specification comes from the Internet Engineering Task Force, the folks who brought us TCP/IP, the Unix networking standard. At its core, SNMP just defines how a network *manager* can communicate with network *agents*. The manager is a program that can accept, manipulate, and, generally, display information about the state of the network—such as the program we saw running on the Sun workstation. An agent is a device on the network, and theoretically it can be anything from a workstation to a bridge, router, gateway, or server. The only requirement an agent must meet is that it must be able to run some SNMP software; thus, it needs its own processor and memory.

SNMP is only a protocol, a specification for how the manager and the agents can communicate. It does not specify the contents of all possible exchanges—just how to make those exchanges. Even the way in which the manager and the agents communicate is fairly simple. The manager and the agents do not need to stay in touch constantly; instead, the manager merely "yells" to the agents periodically. Nor do the agents have to remember

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these conversations; only the manager needs such records, and then only as a management tool.

SNMP is well on its way to becoming a standard. More than 100 vendors have signed up for it so far, with more coming all the time. Some of the vendors are even major workstation players, such as IBM and Sun. Most, however, are makers of network connection devices—the vendors behind the bridges, routers, and gateways that worked so well with the software we saw.

Roadblocks

With all this momentum behind it, you might think that SNMP was unstoppable, maybe even on its way to fulfilling our earlier visions. But that's not the case.

For one thing, SNMP doesn't cover enough ground to meet all our needs. The base specification details only how the manager and the agents communicate. To make our universal-management dream come true, we also need standards for what every possible kind of agent—including workstations and servers—can say to the manager. Some such SNMP-based standards exist, but mostly for bridges, routers, and gateways—hence the wider adoption of SNMP by vendors of those products than by any other types of vendors. Server vendors, for example, have largely ignored SNMP, so SNMP console products typically offer no information about server activity. SNMP also has so far been associated primarily with Ethernet, although work is ongoing to bring it to Token Ring, Fiber Distributed Data Interface, and other types of network connections.

Back to the Future, Part II

The newest and perhaps greatest obstacle to SNMP, however, is a second—and, in many ways, better—proposed network management standard: Common Management Information Protocol.

CMIP comes from the International Standards Organization (ISO), the group behind both the Open Systems Interconnection model and the networking software of the same name. CMIP defines standard types of communication for practically every kind of information you might want about a network—physical faults, security breaches, file operations, configuration data, performance, accounting, and on and on. It's obviously a much larger and more comprehensive standard than SNMP. A companion specification, the Common Management Information Service standard, defines a large set of functions that a manager must provide. You don't have to look long

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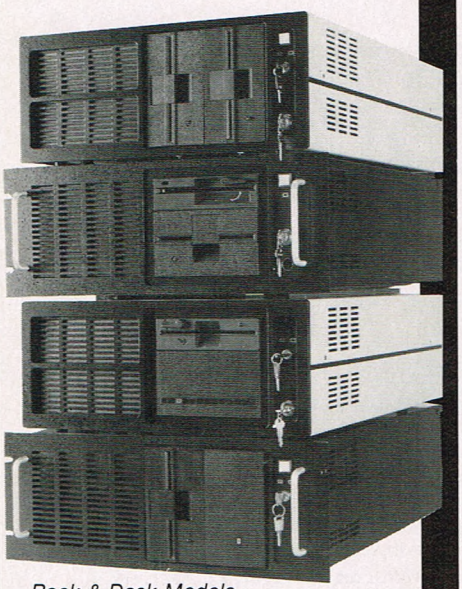
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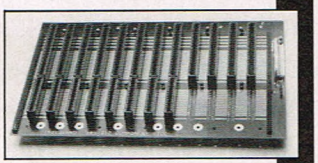
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at the CMIP and CMIS specs to believe that they cover the vast majority—if not all—of the network management options that you're likely to want.

Of course, you pay for all this size. For one thing, CMIP, unlike SNMP, requires a permanent connection between the manager and each agent. Worse, to work fully with a CMIS manager, each agent needs to implement every layer of the CMIP spec, so each agent needs a lot of memory to run the CMIP software. CMIP and CMIS are new enough that we have no hard data on the amount of memory that a full commercial implementation would require, but some estimates run as high as 1 megabyte, with the most optimistic projections in the hundreds of kilobytes. This memory requirement is a problem for network devices like bridges and routers, and it's not likely to sit too well with most MS-DOS PC users.

SNMP is well on its way to becoming a standard. More than 100 vendors have signed up for it so far.

IBM and 3Com have teamed up to propose a solution to this memory problem: the Heterogeneous LAN Management standard. A subset of CMIP, HLM includes only the lower few layers of the larger standard. HLM can work with both Token Ring and Ethernet networks and should cost only 20K bytes to 30K bytes per PC, so it has the potential to bring network management options right to your desktop. Both IBM and 3Com plan to include HLM in their PC networking software, and they're encouraging other vendors to do so as well. HLM does not, however, include any monitoring software or specifications, just an application programming interface on which vendors can build their own management monitors—as both IBM and 3Com plan to do.

Picking a Future

Aside from its memory requirement, CMIP sounds great. HLM isn't as good, but at least it fits on a PC. At first glance, the two seem to offer a great one-two punch: Do HLM now, and then do CMIP as PC operating environments, such as Windows that can handle large software products become more commonly available. Together, CMIP and HLM seem like the death of SNMP.

The thing is, CMIP is the future, and there are network management problems today that can't wait for it to reach the market. The CMIP ISO standards are only in draft form, awaiting ratification. IBM and 3Com say that HLM won't be ready until sometime in 1991. When both are done, users will still face a long wait while all the networking vendors implement these standards and bring their products to market.

Meanwhile, SNMP is out in the real world doing useful work today. That's the bottom line. Network management problems are too important to wait, so everyone should adopt SNMP as quickly as possible. Every network vendor, including the LAN server companies—Novell, Microsoft, and the rest—should embrace this standard. Every server, workstation, and other network device should be able to talk SNMP.

Does this mean we're giving thumbs down to CMIP? No. In fact, we also think that every network vendor should jump on the CMIP bandwagon as soon as possible, so that in four or five years CMIP products will be everywhere.

"But wait," we hear the budget-conscious folks crying, "does this mean that we'll end up using SNMP for a few years and then moving to CMIP? Does it mean we'll end up paying twice for many network management components? Does it mean we're opting for a relatively short-term, imperfect solution, while an almost ideal one is only years away?"

Yes, yes, and yes.

Those questions are good ones, but they beg the most important question of all: Do you really have any other choice? Our answer is no; network management is too vital to today's businesses to wait for a standard that's years away. That's not an ideal answer, admittedly, but right now it's the best one we've got. ■

Mark L. Van Name and Bill Catchings are BYTE contributing editors. Both are also independent computer consultants and freelance writers based in Raleigh, North Carolina. You can reach them on BIX as "mvanname" and "wbc3," respectively.

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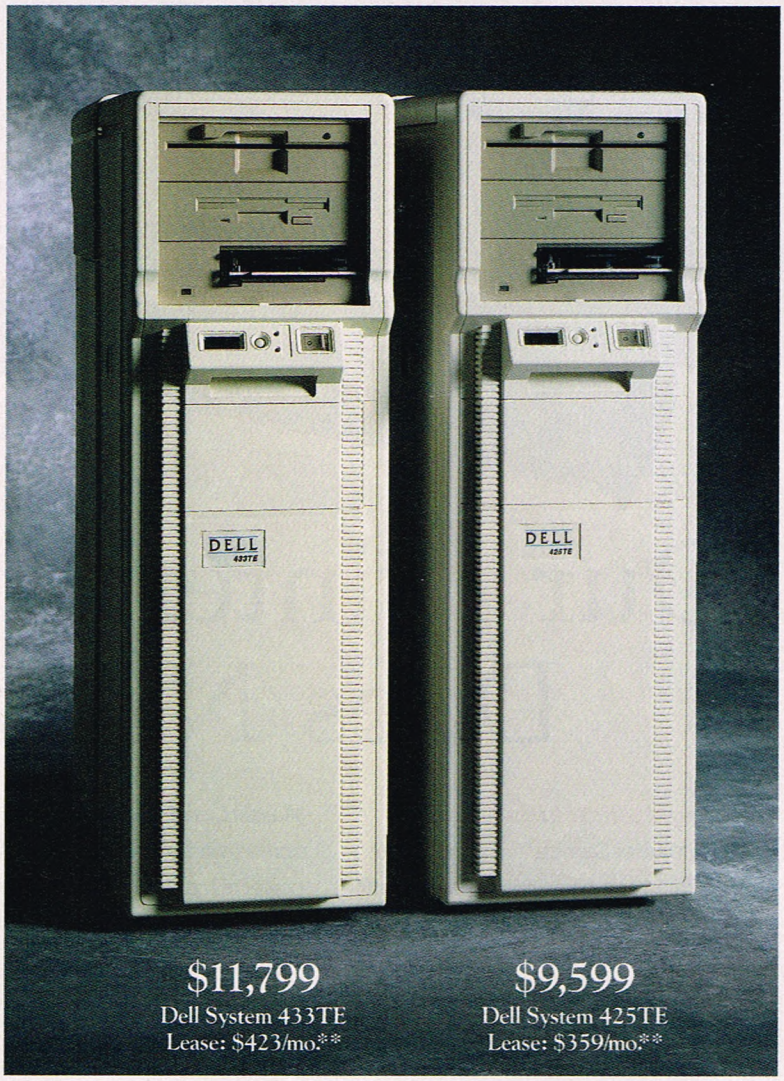
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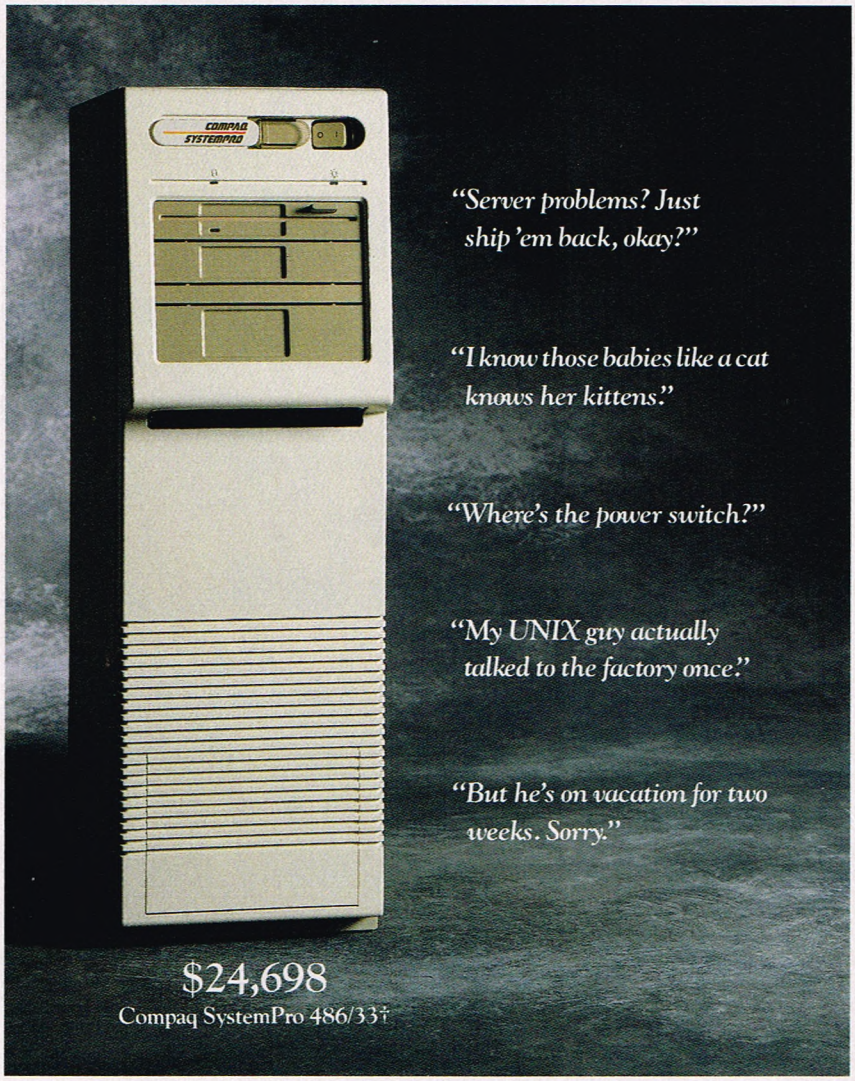
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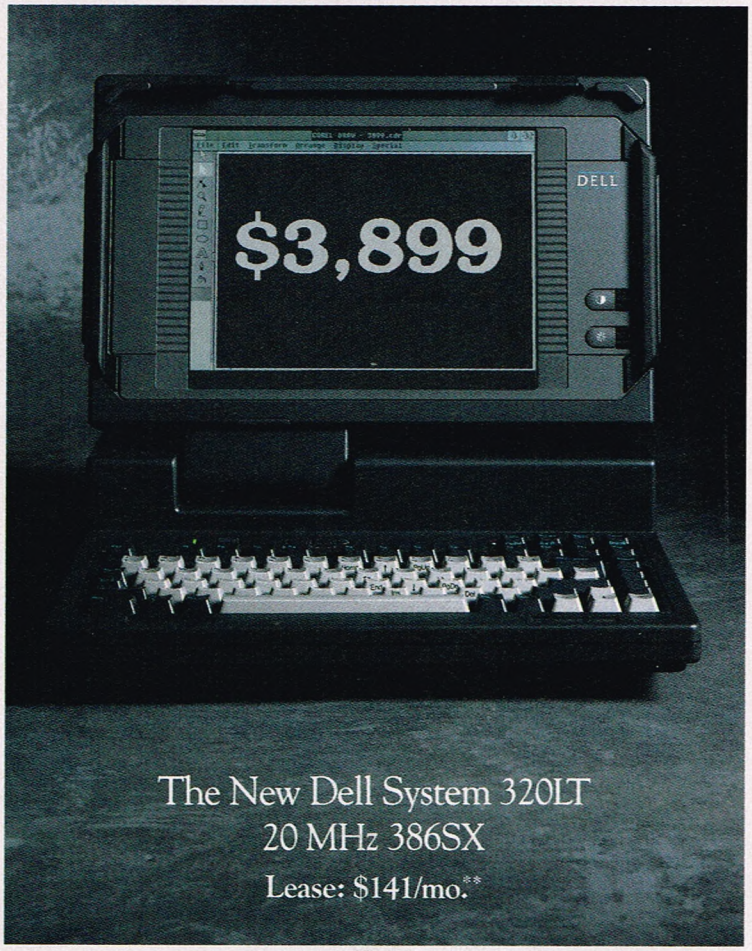
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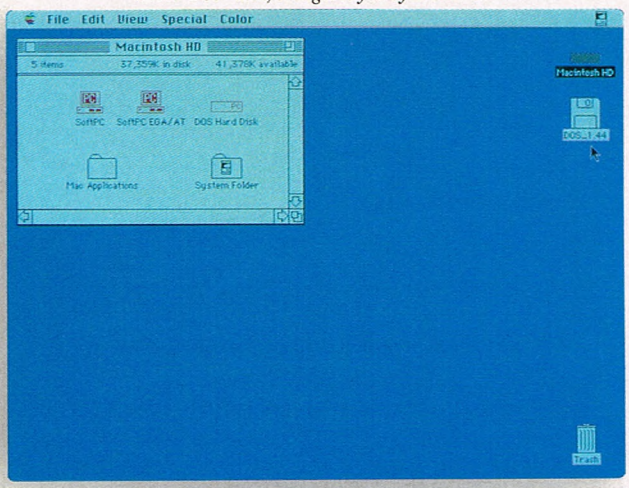
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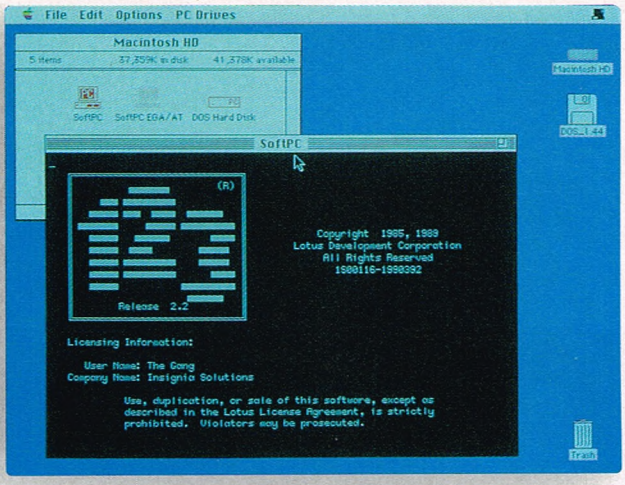
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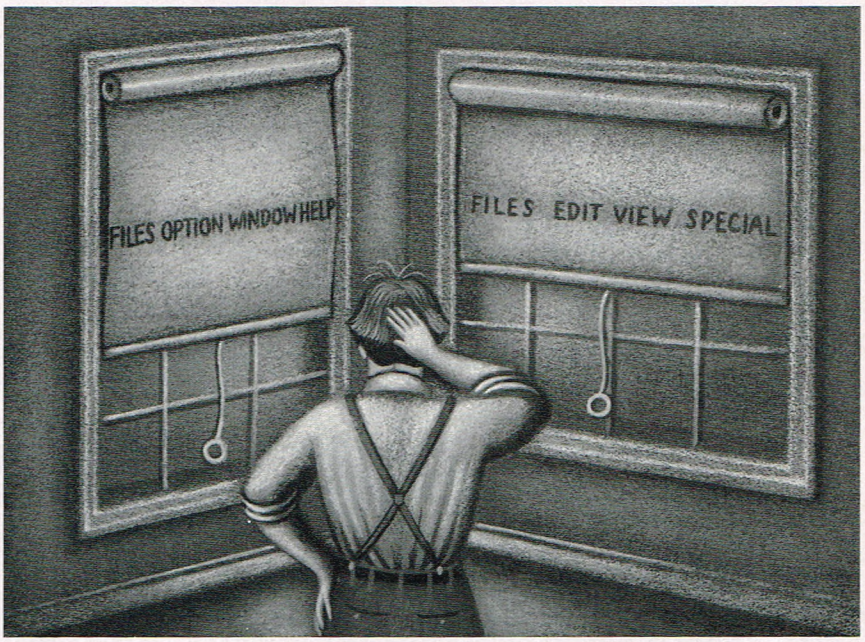
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WORKING WITH WINDOWS 3.0 AND A MAC

Overall, the Windows 3.0/386 combo is an 85 percent Mac



As I have written here before, using Windows 3.0 on a good-quality 386 PC is surprisingly similar to using a Mac IIcx. It's nowhere near an exact match, but it's close enough to force the obvious comparisons. Overall, I call the Windows 3.0/386 combo an 85 percent Mac.

The reality of microcomputing life is that lots of different graphical user interfaces (GUIs), stuck on lots of different operating systems, are going to be the norm for the nineties. Mac and Windows users must learn to get along, because interoperability will be the defining technology. I have had my share of Mac OS/Windows 3.0 attempts at détente, and here are some early tips based on my experience.

Networking

I do a lot of work over computer networks, both at home and at the office. I use both LocalTalk and Ethernet to interconnect Macs, PCs, Sun SPARCstations, and NeXT Computers. For Windows 3.0 to be a viable GUI for me means that I have to make it work with these existing networks.

Right now, that's a big problem. I use both AppleShare and TOPS on the PCs and Macs, while Network File System handles the file sharing over the Unix boxes. Thus, I want to run AppleShare PC or TOPS on my Windows-equipped PCs, or even NFS. But that's not yet possible. None of these file-server technologies are Windows 3.0–compatible.

I've tried loading AppleShare PC and TOPS first and then loading Windows 3.0 on the PCs, but there's not enough memory left in the 640K-byte start-up segment for Windows to fly. I've also tried Windows in real mode (where you lose all the multitasking and extended memory magic) to shoehorn in the networking stuff, but that's been a wash.

Novell's NetWare or 3Com's 3+Share might be an answer for my cross-platform file sharing, since Windows 3.0 has hooks that can support these networked operating systems. But the cheapest version of NetWare that supports all my Macs and PCs as clients would cost me $4600. I don't see that as much of a solution. Plus, I'd need to establish a PC as a dedicated NetWare server, to say nothing of the hassle of Novell network administration.

NFS isn't an answer either, since there is no PC version of it that works with Windows. The best I can do is run my PCs under DOS 4.01 and do my file sharing over the networks under that operating system. Then, I can kill the networks and reboot under Windows to run my applications. Not exactly transparent networking, is it? Let's hope that Apple and Sitka (formerly TOPS) can fix things at their end, and that Microsoft's promised easy adaptability of Windows 3.0 to different networks becomes a reality.

File Exchange

When I've used a Toshiba T3100SX laptop on the road and want to move its files over to my Mac, I have always used Traveling Software's LapLink Mac III. It works well and simply. Luckily, LapLink Mac III works fine as a non-Windows application, so I can continue to use it that way. Since I'm using Microsoft Word for Windows on the T3100SX, I also don't have to worry about invoking file-conversion software or file filters.

I've tried other file-exchange solutions on the T3100SX and on both an Outbound Systems portable Mac and Apple's Mac Portable connected to a Toshiba T5200 running Windows 3.0. I

ILLUSTRATION: TOM SCIACCA © 1990

used a direct serial connection on both Macs to the T5200 and ran Procomm as a non-Windows application on the T5200, while running VersaTerm-Pro on the Macs.

A similar serial connection between the T3100SX and a Mac IIci also worked fine for file exchanges as long as I made sure to use the correct file translators or filters first. For the most part, I use the Apple File Exchange with the Claris, DataViz (MacLink Plus), and Systems Compatibility (Software Bridge) translators for this. I've had no trouble getting PageMaker 4.0, Excel 2.2, PowerPoint 2.0, and other files over to Windows from the Mac.

As more DOS and Mac vendors produce Windows 3.0–compatible software, the transparent exchange of files between these two operating systems should become much easier.

On-Line Service and BBS Access

Over the past two years, I've become addicted to the ease of use offered by Connect's MacNet, CompuServe's Navigator, AppleLink, and America Online. Unfortunately, there is no Windows 3.0 version of AppleLink, and the same is true for America Online, a service dedicated to Mac users with a spiffy GUI.

Thankfully, though, there is a PC version of Connect (PCNet), and I've gotten by with it in the past. Unfortunately, it's not expected to appear in a Windows-compatible version anytime soon, and I can't make it work quite right as a non-Windows application. Although there's no Windows version of Navigator, CompuServe does have a new PC package for making access easier, called the CompuServe Information Manager. But it's not Windows 3.0–compatible either, and it's pretty mediocre compared to all the auto-scripting capabilities of Navigator.

For Windows 3.0 to gain the same reputation as a high-quality interface for on-line services as the Mac, we need Windows-based on-line software written for it.

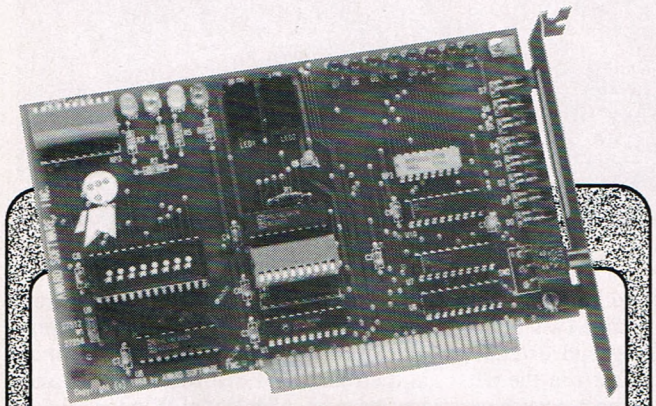
Similarities and Differences Can Aggravate

If you spend more than 5 minutes using Windows 3.0, you realize that it *looks* more like the Mac Finder/MultiFinder than it *works* like it. While Windows 3.0 includes resizable windows, scroll bars, menus, icons, proportional screen fonts, and color, the way they work isn't usually the same as their Mac equivalents.

If you're a Mac person, a number of annoying omissions (e.g., the lack of a Trashcan and different functional menu bars for each Desktop window) can confuse you. If you're used to the clean screen fonts on the Mac, you'll hate the lousy screen fonts under Windows, although Adobe's Type Manager for Windows should help. You'll also find that many of the Windows icons look a tad mediocre.

There are quite a few Windows capabilities that Mac users would love to have: icons that represent parent and daughter windows (which keeps the Desktop tidy), standard interapplication communication in the form of Dynamic Data Exchange that MacFolk have to wait for System 7.0 to savor, true preemptive multitasking with dynamic memory allocation (System 7.0 won't have dynamic memory), and seriously enhanced printer control.

Mac users with anything more than a passing familiarity with that machine



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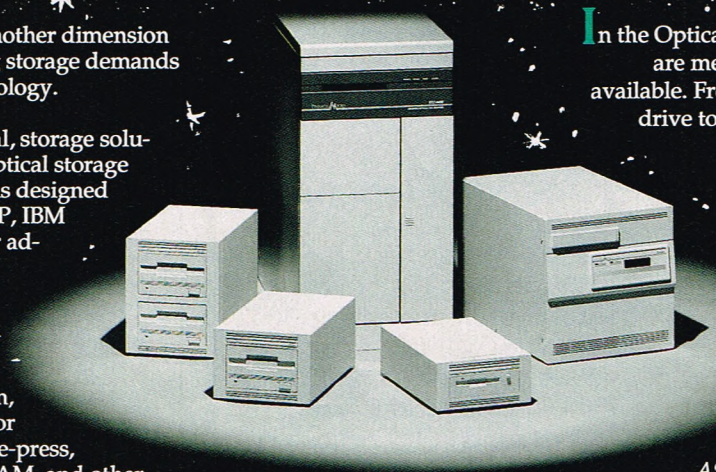
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will peg Windows 3.0 as being different. After a bit more exploration, you'll likely find that it's annoyingly different, despite some of its obvious pluses. After a few months, you'll find yourself asking when Windows 4.0 is coming out to fix all the interface mistakes Microsoft still managed to build into version 3.0.

On the other hand, Windows 3.0 users should be able to switch over to a Mac (or switch back and forth between the two environments) with considerably less trouble, since Windows 3.0 is a vast improvement over version 2.03. And it does look a lot like a Mac. Sometimes looking good is all that matters, I guess.

Tip of the Month: Subscribe to a Newsletter

This past summer proved to be another tough time for computer magazines. An industry that was already condensed has compacted further with the failures of VNU's *Personal Computing*, IDG's *PC Resource*, and CMP's *Macintosh News*.

Surprisingly, though, as some mainstream computer magazines have failed, computer newsletters have gotten stronger. Old standbys like Stewart Alsop's *PC Letter* have gotten bigger and better, while McGraw-Hill's BYTEWEEK has established itself as a reliable weekly for up-to-the-minute computing news and analysis for both PC and Mac users.

Two of my most pleasant surprises, however, come from industry experts relatively new to the newsletter game. Denise Caruso, the gifted columnist of the *San Francisco Examiner* and several on-line venues, has just started a newsletter for working multimedia users.

Called *Media Letter*, this newsletter is exactly what real multimedia people need. If you're using your Mac for multimedia work, or if you expect to in the future, you should subscribe to *Media Letter* (P.O. Box 142075, Coral Gables, FL 33114, (305) 441-1282). It costs from $195 to $395 a year, depending on your institutional affiliation.

My favorite Mac newsletter will soon be celebrating its first anniversary. The *Weigand Report* (P.O. Box 647, Gales Ferry, CT 06335, (203) 464-6188) is written and published by former *MACazine* and *Personal Publishing* editor Chuck Weigand. This newsletter practically begs to be read, since it's jammed with useful and specific tips for Mac novices and Mac experts.

Since much of Chuck's expertise is in desktop publishing, that's the focus, but the newsletter also includes coverage germane to small-business Mac owners. A recent issue had articles on high-resolution plain paper printers, font-transformation software, SCSI-bus screwups caused by multiple SCSI devices, and the compression of TIFF images.

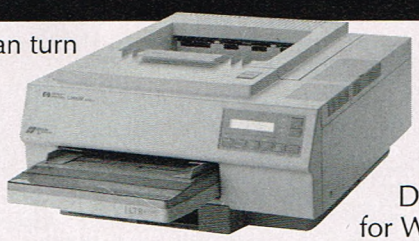
Chuck gives you plenty of theoretical and engineering (he is, after all, a retired Navy lieutenant commander and nuclear submariner) information about the topics he covers, but he also includes plenty of practical tips for solving the problems he reveals. A yearly subscription to the *Weigand Report* (20 issues) costs $128. It's easily worth thrice the price. ■

Don Crabb is the director of laboratories and a senior lecturer for the computer science department at the University of Chicago. He is also a contributing editor for BYTE. He can be reached on BIX as "decrabb."

Your questions and comments are welcome. Write to: Editor, BYTE, One Phoenix Mill Lane, Peterborough, NH 03458.

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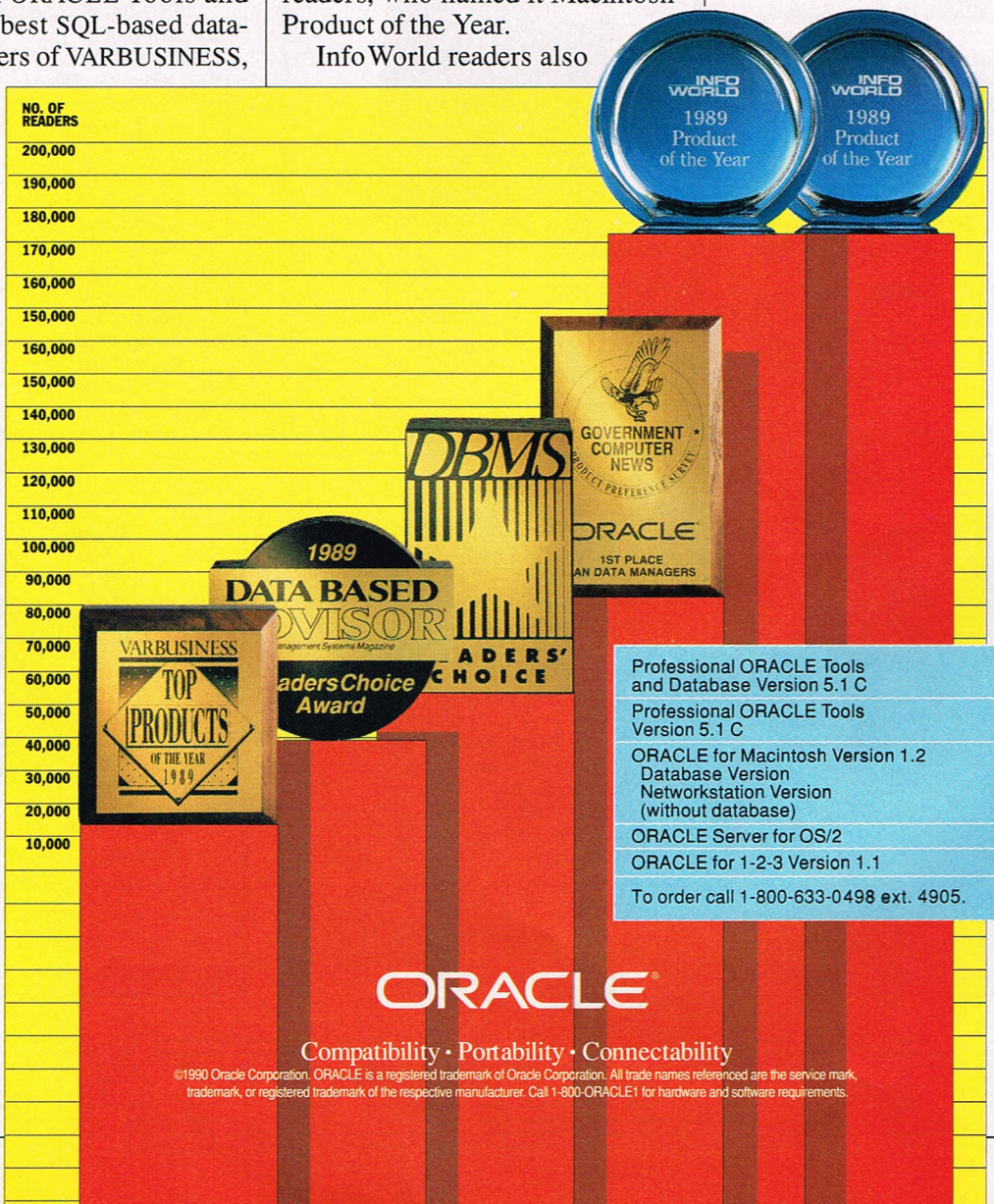
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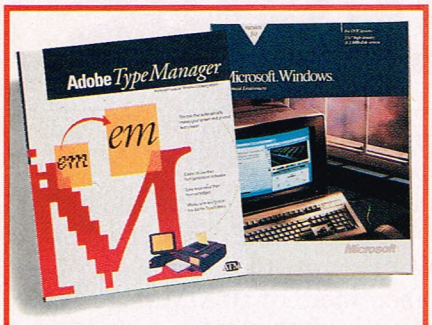
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7392 ◙ Adobe PostScript Cartridge . . . . 249.
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1332 ☐ PageMaker 3.01 . . . . . 499.
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Ashton-Tate ... NCP
4450 ☐ dBASE IV 1.1 . . . . . 499.
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6575 ◙ R & R Relational Report Writer 3B 109.
Corel Systems ... NCP
5506 ☐ CorelDRAW! 1.2 . . . . . 329.
Custom Applications ... NCP
7474 ☐ Freedom of Press 2.2. . . . . 255.
Data Storm ... NCP
4798 ◙ PROCOMM PLUS 1.1 . . . . . 65.
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5611 ☐ Crosstalk for Windows 1.1 . . . . . 129.
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2324 🅁 PC Logo 3.0 . . . . . 59.



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6234 □CarbonCopy Plus 5.2 ..... 119.
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2853 ◉C Compiler 6.0 ..... 339.
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5902 □PC Globe 4.0 ..... 39.
5900 □PC USA 2.0 ..... 39.
Personics ... NCP
4384 ◉Ultravision 2.0 ..... 79.
7048 ◉Monarch 1.0 *(Data Mgmt. Tool)* . 319.
PowerUp ... NCP
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Qualitas ... NCP
7539 □386MAX 5.0 ..... 75.
Quarterdeck ... NCP
6422 □QRAM 1.0 ..... 49.
3221 □Expanded Memory Mgr. 386 5.1 . 59.
3220 □DESQView 2.3 ..... 79.
4586 □DESQView 386 5.1 ..... 129.
Reality Technologies ... NCP
6572 ◉WealthBuilder 1.1 ..... 145.
Reference Software ... NCP
4396 ◉Grammatik IV 1.0 ..... 52.
7483 ◉Grammatik for Windows 1.0 ..... 52.

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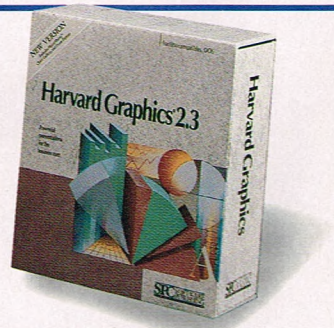
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5799 ◉Ami Professional 1.2 ..... 309.
Softlogic Solutions ... NCP
3542 □Software Carousel 4.0 ..... 55.
Software Publishing ... NCP
3499 □PFS:First Publisher 3.0 ..... 99.
3478 □PFS:First Choice 3.02 ..... 105.
3496 □Professional Write 2.2 ..... 179.
3482 □Harvard Graphics 2.3 ..... 359.
Spinnaker ... NCP
7604 ◉Plus for Windows 1.0 ..... 289.
Symantec ... NCP
3152 ◉Norton Commander 3.0 ..... 105.
6397 ◉The Norton Backup 1.1 ..... 105.
3146 ◉The Norton Utilities 5.0 ..... 125.
3425 □Q&A 3.0 ..... 229.
3431 □Timeline 4.0 ..... 469.

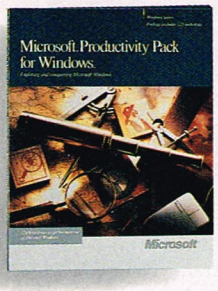


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6253 ◉Publish-It! 1.1 . . . . . 115.
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5179 ◉LapLink III 3.0 . . . . . 95.
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6246 ☐Volkswriter 4 1.02 . . . . . 109.



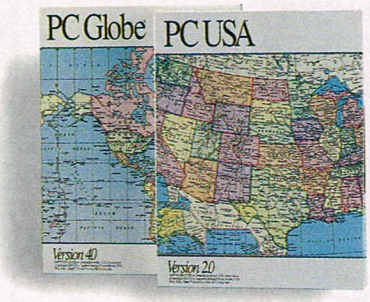
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3804 ☐WordPerfect 5.1 . . . . . 265.
6685 ◉DrawPerfect 1.1 . . . . . 279.
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6791 ☐WordStar Prof. 6.0 . . . . . 279.
Xerox ... NCP
7796 ◉Ventura Publisher for Windows 3.0 569.
XTREE ... NCP
6161 ◉XTreePro Gold 1.4 . . . . . 75.
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7016 ◉PC Paintbrush IV Plus 1.0 . . . . . 119.
7014 ◉PC Paintbrush Plus for Windows 1.12 89.

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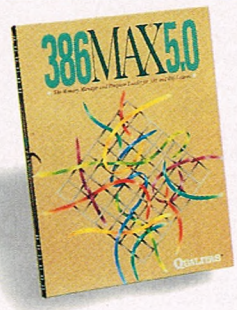
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5851 ◉SimCity . . . . . 33.



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6972 ◉Conquests of Camelot . . . . . 39.
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6436 ◧Hunt for Red October . . . . . 20.
4659 ◉Chessmaster 2100 *(CP)* . . . . . 35.
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7564 ◉Young Math *(ages 5 to 8)* . . . . . 22.
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6795 SixPak 286 512k . . . . . 179.
4107 RAMpage Plus 286 512k . . . . . 419.
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7061 BOCARAM/XT 0K *(0-2 Meg, LIM 4.0)* 99.
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6999 I/O Board for Microchannel S/S/P . 109.
6995 SuperVGA *(800 x 600, 16/8 bit)* . . . 115.
7026 1024 VGA *(16 bit non-interlaced)* . . 149.
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7400 2 Pos. Laser Compatible Switch Box 109.
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Canon ... 1 year
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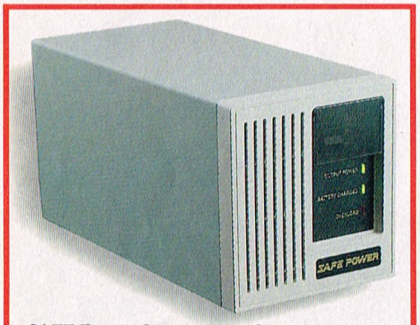
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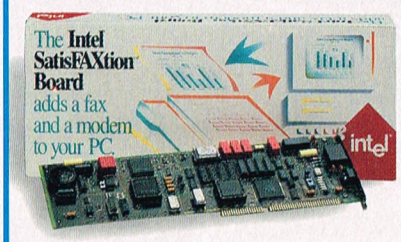
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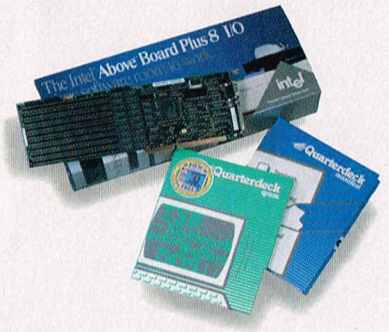
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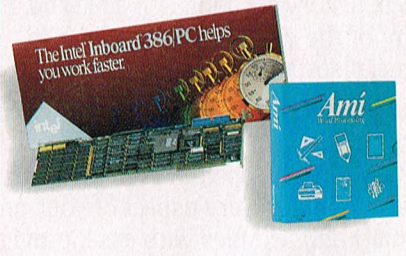


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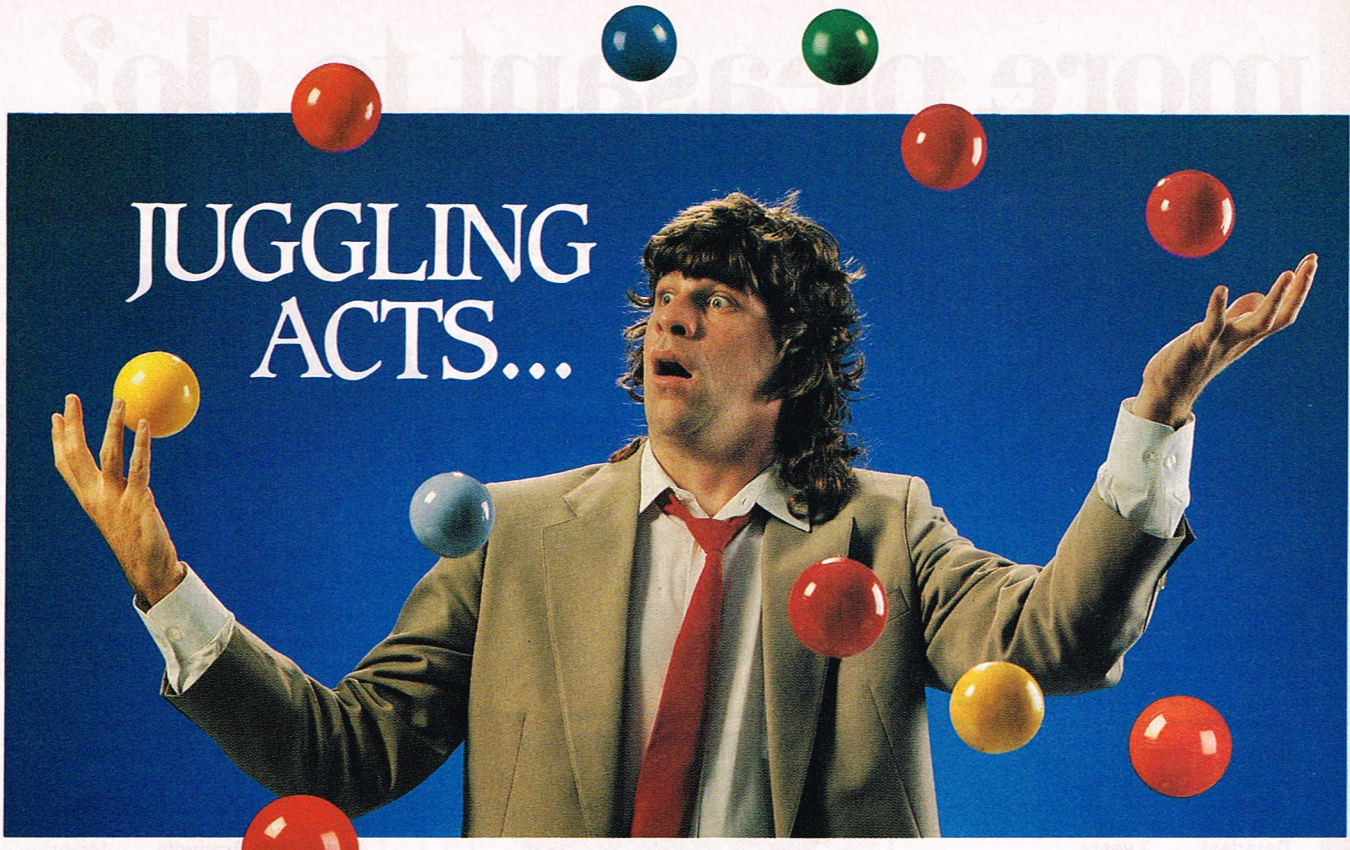
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NOT QUITE UNIX

Tribulations and treats of using a $100 Unix clone



Last month I mentioned that I had received a copy of Coherent, an operating system for 286- and 386-based machines that was designed to be very much like Unix. (The Mark Williams Company sells it for $99.95.) I had hoped to report that it would make a good base for an inexpensive UUCP (Unix-to-Unix copy) connection, as well as a Unix learning base for people with DOS machines. Alas, that doesn't seem to be the case yet, at least for me.

Building My System

Installing Coherent was pretty straightforward. There are only four high-density floppy disks to work with, and if you have a free partition of at least 10 megabytes on your hard disk, you're ready to go. I didn't have one, so I had to do some long-overdue partition rearranging on my 286 clone. Between some DOS repartitioning software I had around and the tools supplied with Coherent, it wasn't too bad, even though I'm strictly a novice when it comes to DOS. I hooked up a spare terminal and can report that Coherent is indeed multiuser and multitasking, with quite decent response.

Coherent comes with some truly remarkable features, considering it's a Unix look-alike. Apart from the usual 200 or so basic file-manipulation and system-maintenance commands, it also has a driver program for Epson printers, `troff` (with output to the Hewlett-Packard LaserJet), and software development programs such as `lex`, `yacc`, `make`, `sed`, and `awk`.

I was very excited that Coherent came with a set of UUCP programs. (OK, it's a bit of a misnomer, but if they called it Coherent-to-Coherent copy program, or CCCP, it would sound like a Soviet space vehicle!) UUCP is the means by which all Unix machines can communicate with each other via phone lines. A functioning UUCP package, together with the mail program also included in Coherent, would give you access to the worldwide UUCP network.

So, my scheme was to first hook up Coherent via a direct-wired UUCP connection (far faster and easier, generally, than attempting to hook up a modem) to my regular Unix machine and then download programs to Coherent and attempt to recompile them.

Unfortunately, I was unable to get Coherent to talk to Unix. It wouldn't dial out at all, whether the port was enabled or not. The dial-in attempts from the Unix machine showed that Coherent was indeed answering with the expected prompts. However, once past the password check, Coherent would respond with an error message and return a LOGIN FAILED status message to the Unix connection.

I called the Mark Williams Company's technical-support line and talked to someone who went through a number of likely reasons for the failure. He also came up with a few suggestions that didn't seem to bear on this situation at all (for instance, removing a UUCP reference in the `/etc/domains` file). Together, we eventually concluded that there was no reason why it shouldn't be working; it just wasn't.

Hard Aport

I then tried porting the xcomm package to Coherent, in response to a query from a reader about a method of dialing out that was simpler than using the Kermit utility provided in Coherent. This revealed that some signals in Unix System V that are needed for compiling xcomm

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(which is the only communications program I have that's small enough to fit into Coherent's 64K-byte space) are not implemented in Coherent.

Just for testing purposes, I commented out all references to these signals. Unfortunately, Coherent was unable to put the object modules together. The error message said that the loader couldn't relocate modules compiled for separate I/D (instruction and data) space, yet I hadn't compiled or tried to load with that option (nor could I find it in the manual). Using the `file` command showed that all the object modules had properly compiled as relocatable code. Very strange.

So how did I get the xcomm source files onto Coherent? Coherent has an all-purpose utility called `dos`, which does everything from formatting DOS disks to file transfer between Coherent and DOS. In fact, my only complaint with that command is that there are too many options, making it too easy to delete files or format a disk when you don't intend to.

I did have a little problem figuring out how to address the DOS floppy disk drive, since none of the references listed under the `dos` command gives the information. After searching likely places, I finally discovered that the information is under the entry "fd" in the manual, where I discovered by trial and error that a low-density disk is called `/dev/f9a0` and a high-density disk is called `/dev/fha0`. The default is to access the DOS partition on the hard disk.

Think Small

A word about the 64K-byte limit is also in order. This was a familiar problem back in the early days of Unix, when Unix was almost always implemented on one of Digital's PDP-11 computers. All programs had to fit into just 64K bytes of memory, even when there was 256K bytes on the machine. The improved PDP-11/70 model, a large minicomputer, allowed programs to have 64K bytes of executable instruction code and 64K bytes of static and dynamic data space, which allowed you to write larger programs.

Coherent's compiler, written to work on both the 386 and the smaller 286, is limited to "small model" compilation, and therefore also bound by the 64K-byte limit for programs. Having studied much of the 1000-plus-page Coherent manual and all the promotional literature, I could find only a single sentence that acknowledged this, and that was buried in a note under the heading "Data Formats," rather than in any information about the compiler or even the loader. Unless, of course, you take the company's "small is beautiful" motto literally.

Because BYTE has published its Unix benchmarks with the intention of making them portable, I then decided to try them. I was rewarded to see that many of the programs compiled cleanly (some were missing references to time constants, though).

Unfortunately, the benchmarks did not run as delivered, because the shell

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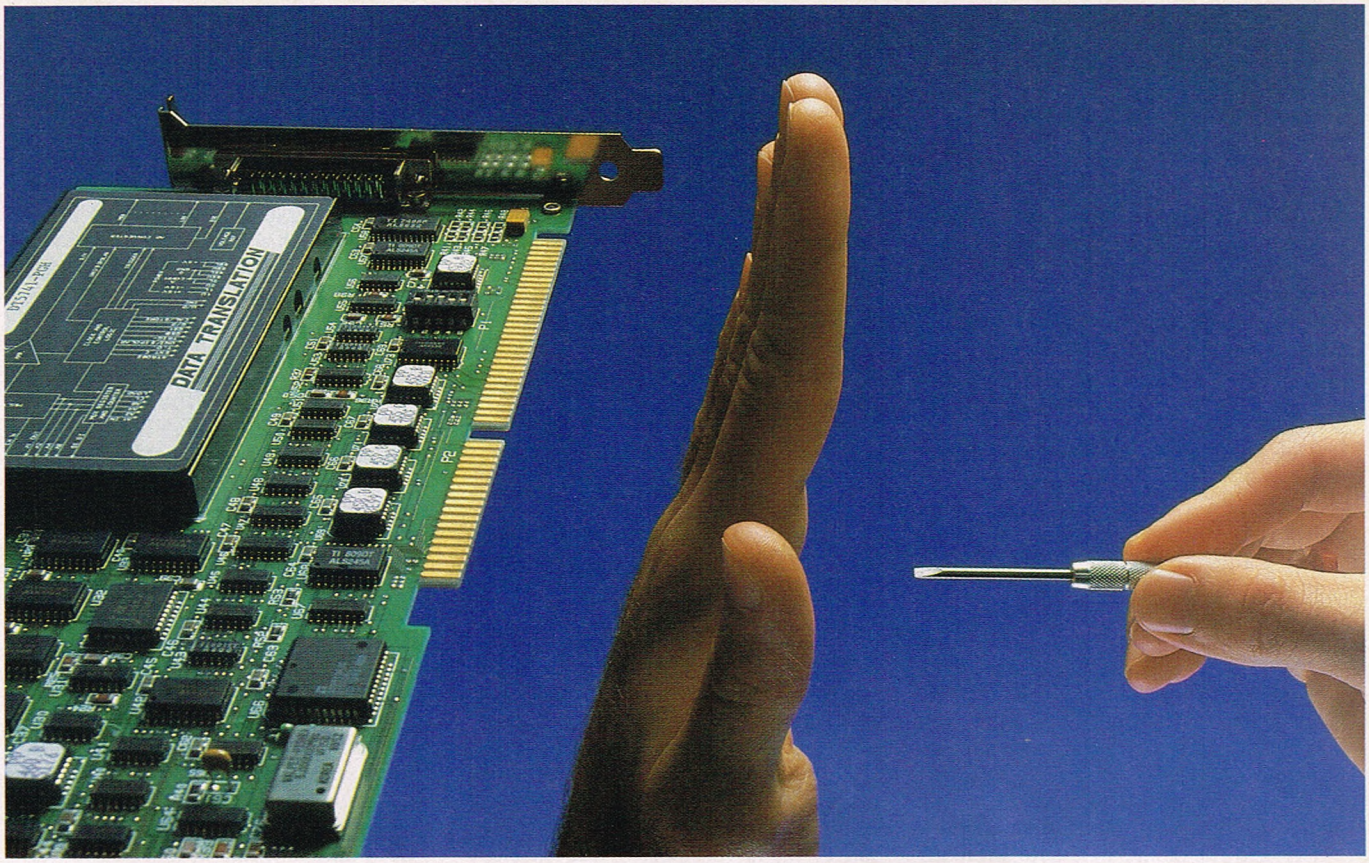


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driver program makes heavy use of the Bourne shell's keyword parameters, which apparently are not implemented in Coherent. In that sense, it's a bit misleading of the Mark Williams Company to refer to its shell as a "Bourne shell," since that implies that its shell is either compatible with, or a derivative of, the standard Unix shell (written by Steve Bourne).

By looking around the Mark Williams conference on BIX (mwc/coherent), I've found that I'm having a bit more trouble than some other folks. Several people have gotten their UUCP running and are all ready to set up a Usenet node. Others are working on ways of compiling `csh`, `vi`, and similar popular Unix programs. Clearly, just because I've run into a snag or two doesn't mean it can't be done.

I also learned from BIX that the Mark Williams Company is planning a virtual-memory capability for the 286 version of Coherent, plus a full-featured 386 version, for next year. Both would presumably get rid of the 64K-byte limit imposed by the small-model compiler.

At this point, I'm at a bit of a standstill. If your intention in buying Coherent is to use it for creating a UUCP or Usenet node and downloading public domain programs for compilation and use, or for developing programs to be used on true Unix or Xenix systems, then Coherent's current compiler limitations, slightly nonstandard features, and the other problems I've experienced might give you pause.

On the other hand, if you want a Unix-like development and learning system for less than $100 that supports multiple users, can be coresident with a DOS installation, and can transfer text files to and from DOS floppy disks and hard disk partitions, I don't see how you can go wrong with Coherent.

A Personal Note

My offer to send out the list of public-access Unix systems (see "Free Software!" in the June BYTE) was, to put it mildly, very well received. I had no idea that so many Unix-literate people read BYTE, let alone my column. I have my wife Susan to thank for most of the envelope stuffing and sealing.

Enough of you wrote with interest about my new publication, *Unix Video Quarterly*, that this is a good time to talk briefly about it here. I started *Unix Video Quarterly* as an alternative to traditional industry newsletters, partly because of my experience in video and film production. Certainly, the move toward Unix graphics software and user interfaces was a factor; imagine trying to describe how OSF/Motif differs from Open Look by using text alone! I also realized that sometimes you have to experience things to totally understand them, and video technology is the closest thing to actually being on the scene. If you want to know more about *Unix Video Quarterly*, contact me at P.O. Box 220, Rescue, CA 95672, (800) 843-8649, or on BIX as "fiedler." ■

David Fiedler is executive producer of Unix Video Quarterly *and coauthor of the book* Unix System Administration. *He has helped start several Unix-related publications. You can reach him on BIX as "fiedler."*

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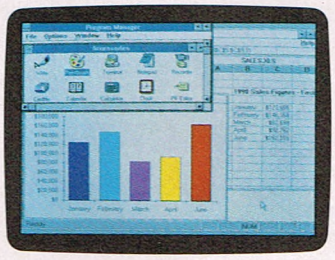
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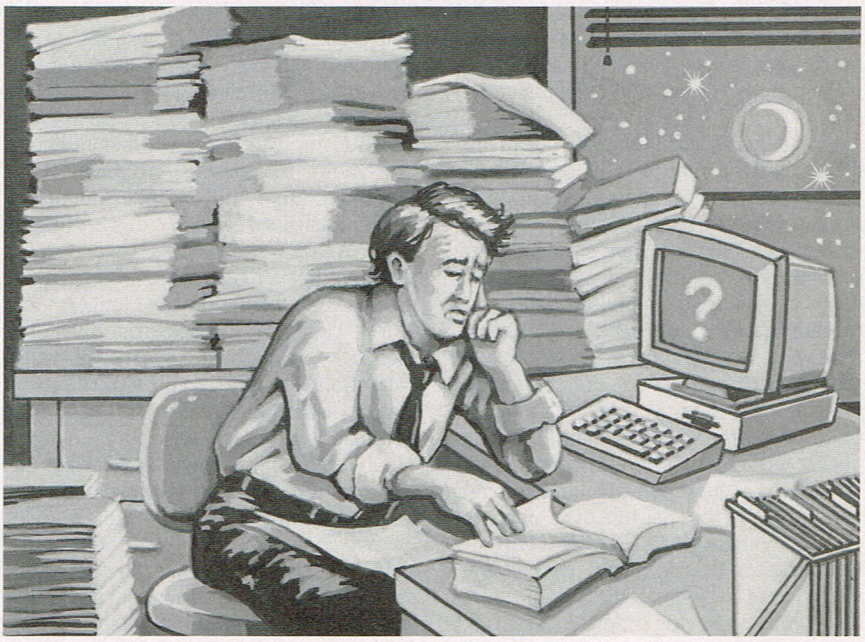
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TALES FROM THE TRENCHES

An OS/2 device-driver specialist talks shop



In January of 1989, I was giving a presentation on OS/2 to representatives of a prospective client. They had a DOS-based system for data acquisition that lacked the ability to simultaneously gather and process data. They had done their homework and concluded that OS/2 could do the job, but they weren't convinced that Unix could not do the job as well.

It was a perfect application for OS/2. The system had to monitor serial-bus transactions and voltage levels in real time, and it had to act on certain conditions immediately. This quickly ruled out Unix, which lacks a preemptive, time-critical kernel.

I gave an upbeat presentation, and everything was going well until one of the senior engineers asked an obvious question: "Of course, we can get device drivers for our special hardware, right?" I did some hand-waving and went on to other topics, promising I'd get back to them regarding the drivers.

When I called the various hardware vendors, I got the same answer every time. "Sorry, we only have DOS drivers. We'd like to support OS/2, but we don't have anyone who knows how to write them. We understand they are extremely hard to write, and only a few customers have asked for them anyway." I decided to find out why. Why should writing a device driver for OS/2 be so difficult?

I packed my bags and headed out to Microsoft University for the OS/2 Driver Writing course. The class ran for one week, and it was one of the most intense I have ever attended.

Device-Driver Basics

When an OS/2 application needs to perform I/O, it makes an I/O request call to the kernel. The kernel verifies the request, translates it into a driver request packet, and calls the device driver for service. The driver handles all the hardware details: I/O addressing, timing, register setup, interrupt handling, and error checking. When the device responds, the driver massages the data into a format recognizable by the application, sends back the data (or a status message), and notifies the kernel that the request is complete.

If it can't handle the request right away, the driver may either block the requesting thread or return a "request not done" to the kernel. Either way, the driver relinquishes the CPU and lets other threads run. If there's an error, the driver relays it to the kernel along with a "request complete" status.

What makes OS/2 drivers unique is the need to operate in both real mode and protected mode. Addresses computed in real mode are not valid if the system switches to protected mode, and vice versa. The driver has to handle such mode switches on the fly. Understanding this bimodal operation is the key to writing OS/2 1.x drivers. Several Device Helper (DevHlp) routines support bimodal operation, but learning how to organize them properly can be harrowing.

Jumping into the Deep End

When I got back from Microsoft University, I was anxious to plunge into my first driver. I ordered the device-driver development kit (DDK) from Microsoft, which comes with the all-important kernel debugger. KDB is a replacement kernel that, among other things, has knowledge of driver structures. For instance, to display a request packet, you can use the command `.d req es:bx`. KDB formats the data and displays it in request packet form. Don't even think about writing an OS/2 driver without this tool!

I began with a simple, do-nothing

ILLUSTRATION: TOM CENTOLA © 1990

driver based on examples given in the course. It worked perfectly. Next, I tackled the real project. My client needed a driver for an eight-channel A/D board. The board used an intelligent interrupt-driven controller and could do DMA transfers. I fumbled furiously through my student documentation for examples of how to implement such a driver and broke out in a cold sweat. There were no examples of interrupt handlers, no examples of DMA operation, and no examples of user-defined I/O control functions.

Microsoft, when I called for help, referred me to Compaq (I'm using its version of OS/2). Compaq referred me back to Microsoft. I searched the computer bookstores to no avail. Finally, I just rolled up my sleeves and began to experiment.

The driver's job is simple—in principle. It has to manage requests from the kernel and return results to the application. An OS/2 driver receives two kinds of requests: Some can be completed immediately, and some can't. Requests come in by way of a standard data structure called a request packet. The kernel sends the driver a bimodal pointer to the request packet. Since the driver must operate in real mode or protected mode, the bimodal pointer ensures that the request packet will be accessible in either mode.

When a request can't be handled right away (e.g., in the case of a disk seek), the driver (by means of a set of DevHlp routines) places it in a queue. Disk drivers can choose to sort pending requests for disk seeks in sector order, to minimize seek time.

OS/2's threaded architecture assigns one extra responsibility to the device driver. When a driver can't handle a request right away, it blocks the requesting thread; when it completes the request, it unblocks the thread.

Tools for Driver Development

The DDK comes with a three-ring binder containing driver structures, descriptions of the DevHlp routines, and instructions for using the KDB. I found only the first 40 or so pages useful. The book does describe the DevHlp routines in detail, but it contains no examples of working drivers.

I write all my device drivers, including interrupt handlers, in Microsoft C 6.0 with maximum optimization. Don't waste your time writing your driver in assembly. Writing a device driver in C takes about half the time it would take to write the same driver in assembly, and the driver will work just as well.

Another useful tool is DDC.LIB, which is a C-callable device-driver library from PentaSoft (17541 Stone Ave. N, Seattle, WA 98133, (206) 546-0470). Probably the most important function in DDC.LIB is Transfer, which transfers data between the driver and applications and accounts for mode switching during the transfer. It handles transfer of data from virtual memory to physical memory, physical to virtual, virtual to virtual, and physical to physical. If you're serious about OS/2 driver development, this library is a must.

Light at the End of the Tunnel?

Anyone who has written drivers for other multitasking operating systems (e.g., Unix or VMS) will have a good foundation for OS/2 driver development. Microsoft estimates that it takes an experienced C programmer who has attended the Microsoft University OS/2 Driver Writing course four to six months to write his or her first OS/2 driver. Subsequent drivers should take two to four months. Disk drivers are significantly more complex and may take longer.

My first driver took roughly three months to write. The next one took only two months, and I was able to write a few simple drivers in a week or so, so it does get easier with practice.

Although OS/2 device drivers are becoming more common nowadays, the situation remains fairly grim. Most of them are for specialized hardware and aren't readily available. What's needed are standard, general-purpose drivers that can be adapted to more generic hardware. For instance, I would like to see an OS/2 driver for a CD-ROM drive, fax card, or tape drive, yet none are available. Why not? There are certainly more customers now who need OS/2 drivers. Without them, the operating system of choice may not be OS/2.

OS/2 2.0 won't make the task of writing device drivers any easier. True, version 2.0 will run DOS applications in protected mode, so the driver won't have to concern itself with bimodal operation. But the driver architecture for DOS programs will change radically. DOS programs will now call a Virtual Device Driver instead of accessing the device hardware directly. The VDD will massage the request and send it to a Physical Device Driver. The PDD will perform the low-level hardware communication with the device and send the data back to the VDD.

The VDD interface is new, while the PDD is nothing more than an OS/2 1.x bimodal driver with the real-mode sections removed. The VDD will emulate the BIOS and other interrupt functions, letting a DOS application assume it is talking directly with the device when it is actually communicating with the VDD. Protected-mode applications will continue to call OS/2 drivers, as in version 1.x, but can use 0:32 ("flat model") addressing.

In June, Microsoft announced a new device-driver architecture for mass storage devices called the layered device-driver architecture (LADDR). Microsoft claims that LADDR can reduce by 90 percent the time to develop an OS/2 mass storage device driver. I hope this is true, but based on what I've seen so far, I wouldn't bet the farm on it.

A new DDK will come with standard driver code, so the developer need only add the code specific to the device itself to implement a fully functional driver. I haven't seen the new DDK yet, so I can't verify Microsoft's claims. At the time of this writing, Microsoft still had no firm release date for the LADDR kit. Non–mass storage drivers will continue to be written using conventional methods.

Neither IBM nor Microsoft has done enough to help the people trying to produce the drivers that OS/2 so desperately needs. The DDK upgrade from version 1.1 to 1.2 is way behind schedule, and the NDDK, used to develop network card drivers for the Extended Edition, is also late. The version 1.1 DDK does not work with PS/2 machines, so drivers must be developed on Industry Standard Architecture bus systems.

Information is still sketchy and incomplete. Although more books have appeared, none show examples of device drivers written in C. Most of the available documentation describes the DevHlp routines and their calling sequences, but not how to organize them into an actual driver.

What is needed is a driver writer's guide to take the mystery out of OS/2 driver writing. The guide should contain examples of actual drivers written in C, not scattered code fragments in assembly. It should also contain a list of helpful functions to aid in driver coding and debugging. Until such information becomes available, device drivers will remain the Achilles' heel of OS/2. ■

Steve Mastrianni is an independent consultant in South Windsor, Connecticut, who specializes in OS/2 device drivers. He can be reached on BIX c/o "editors."

Your questions and comments are welcome. Write to: Editor, BYTE, One Phoenix Mill Lane, Peterborough, NH 03458.

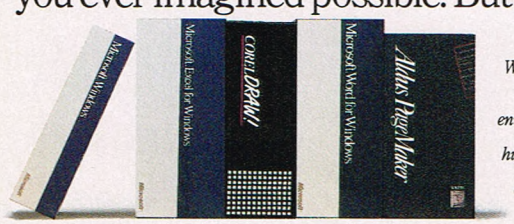
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SHORT TAKES

BYTE editors' hands-on views of new and developing products

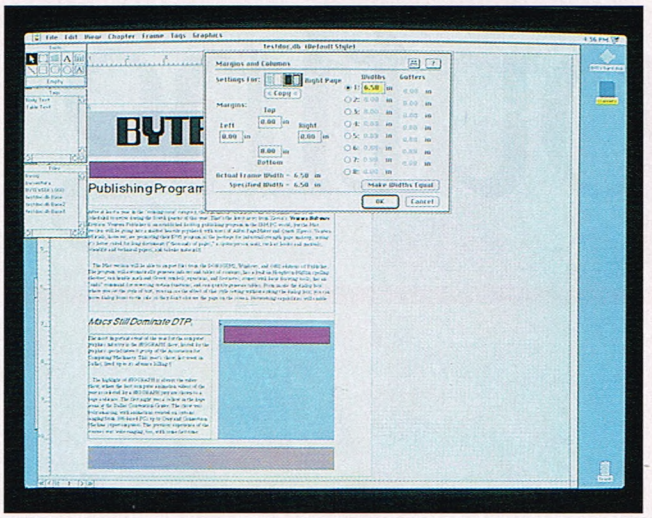
Ventura Publisher, Macintosh Edition 1.0

ScanMan 256

NewWave 3.0

WinSleuth

WordPerfect Rhymer



Ventura Meets the Mac

If you work in a mixed-machine environment in which some people are using Ventura Publisher on their PCs, the arrival of **Ventura Publisher, Macintosh Edition 1.0**, is good news.

Ventura Mac is a straightforward port of the version running under Windows, which makes jumping between systems easy; if you've learned one, you've basically learned the other, and that's what platform hopping is all about. I was able to take a diverse bunch of Ventura files that the BYTE Lab staff had generated on DOS machines, move them to the Mac (using the BYTE LAN and LapLink), and open them up, with their styles and formats intact. This was painless. The fact that you can easily swap Ventura-published documents between PCs and Macs is one of the greatest advantages of this program. Only Aldus PageMaker 3.0 currently provides this capability.

Working in a diverse environment is a Ventura forte. Besides letting you swap between Macs and PCs, this program will pull in text from most word processors you're likely to run across and graphics from most drawing or painting programs.

Ventura is also good at working with long documents. You can line up a string of text files, and the program will run them from page to page, almost automatically, setting up the extra pages as needed. Ventura is built for this kind of work. With its cross-referencing and indexing capabilities, it's essentially a book-oriented page composer.

For doing a long but straightforward publication—no fancy layouts, few graphics—Ventura is a good choice. But for documents with a snazzier look, a more complex page structure, and heavy on the graphics, Ventura is—and here we walk into the shadowy land of subjectivity—hard to work with. Maybe I've been using PageMaker too long, but I find it far more flexible for page design. Its approach, descended from the cut-and-paste world of the composing room, feels right. Ventura is more geometrical. Like some other popular programs, Ventura uses frames. Everything you do has to be within a frame (a rectangular area). You can expand and shrink these frames, and you can move them around on the page easily enough, but we're still talking rectangles. I find this confining.

While PageMaker is an excellent tool for designing layouts, letting you freely move things around and change widths, lengths, and shapes of columns, Ventura is more of a layout fulfillment program. I'd recommend sketching your page design on paper first.

Ventura does beat the pants off PageMaker in a couple of things, particularly working with tabular material. Setting up a table with PageMaker almost hurts. Ventura has a wonderful dialog box in which you specify how many rows and columns you want; you hit a button, and there it is—a nice grid that you can jump around in, from cell to cell, using pointer or cursor keys. The program also excels at setting up equations, which can be a typesetter's nightmare.

Another of Ventura Mac's strengths is in stylizing the text on the page. The program will let you assign a style (e.g., type of font or character size) to every paragraph. You can keep these different styles in a catalog of sorts. This collection of style sheets can also include specifications for the page itself.

There's not room here to cover all the capabilities of Ventura. For a better look at this and other desktop publishing packages, see "Is the Typesetter Obsolete?" in the October BYTE. And before you buy, take them all for a test drive.

Page-layout software, like any other program that combines functionality and aesthetics, is a highly subjective matter. What one person finds excellent is execrable to someone else. What one user finds intuitive is arcane to another. I know totally reasonable people who swear by Quark XPress, and professional graphics designers who concoct fine-looking materials with Ventura. Although I wouldn't want to switch from PageMaker to Ventura, I can't say it's not right for you. This is a good program that does what it's designed to do. The question is: Does it do what *you* want to do?

—D. Barker

THE FACTS

Ventura Publisher, Macintosh Edition 1.0
$795

Requirements:
Mac with 2 MB of RAM, System 6.0.2, Finder 6.0.2, and a hard disk drive.

Ventura Software
15175 Innovation Dr.
San Diego, CA 92128
(619) 673-7524
Inquiry 1160.

Logitech Puts Photo-Realism in Windows



The **ScanMan 256** is a 256-gray-level scanner that can scan at up to 400 dots per inch. It is similar in appearance to previous Logitech scanners but has a number of functional improvements. The scanner itself is in a head a little over 5 inches wide. Below this is the body of the scanner, which you hold to move it. The body has a number of switches that you use to set the various scanner modes. The ScanMan 256 also has an indicator light that shows if a scan is being made at the right speed.

The ScanMan 256 is designed to be used in a Windows 3.0 environment. It comes with a gray-scale scanning and editing package called Ansel, which controls the scanner directly from within Windows 3.0 and provides some easy-to-use tools for editing. Logitech has provided a simple DOS Scan utility that lets you scan, view, and save images without entering Windows 3.0 or using Ansel. However, it isn't as flexible or as easy to use as Ansel, and it doesn't include editing tools.

Installing the scanner and software is easy. Logitech has set the defaults to match the most likely free configurations. All I had to do was plug the scanner board in my system, plug in the scanner, install the software using the supplied Install program, and start scanning. Setting up the scanner in any of its different modes is done simply by setting the switches. The controlling software reads these automatically and adjusts accordingly.

Choosing the right setting for a scan is not a simple matter. With the range of options available, it becomes important to make a careful choice. The problem lies in the size of the image files created at high resolutions with large numbers of gray scales. A simple 2- by 2-inch image takes up almost 2 megabytes at 300 dpi with 256 gray scales. This taxes the memory of the system considerably. Logitech has devised its own system for paging image data to and from disk to counteract this, but the bottom line is that if you want to scan images at 300 or 400 dpi with 256 gray scales, you'll need a lot of memory. What setting you choose also depends on whether you want to use line art, perform optical character recognition, or have true gray-scale images.

I scanned a range of actual photographs and some from magazines, and the quality of the results was extremely good at all levels. Overall, I found the ScanMan 256 an extremely powerful and flexible scanner. It is useful for scanning small documents and all kinds of images. But I would recommend that you make sure that your system can deal with the kind of large files that a scanner this powerful can create.

—Owen Linderholm

THE FACTS

ScanMan 256
$499

Requirements:
IBM PC or compatible running Windows 3.0.

Logitech, Inc.
6505 Kaiser Dr.
Fremont, CA 94555
(415) 795-8500
Inquiry 1161.

Hewlett-Packard's Newest Wave for Windows

One of the most interesting—and potentially most important—applications to appear for Microsoft Windows 3.0 is an updated version of Hewlett-Packard's **NewWave** environment. There are two ways of looking at this program: as a set of reasonably priced utilities for Windows, or as a glimpse of what most graphical user interfaces (GUIs) will be like in the future.

This latest version of NewWave introduces an Agent capability, which is essentially a powerful keyboard macro facility. To perform a given task, all you need to do is select that task's icon and drop it on the Agent icon, which looks remarkably like Patrick McGoohan in the "Secret Agent" TV show. One of the nice things about this macro facility is its ability to do tasks on a routine basis (e.g., every hour, day, or week).

Another important feature of this new version is network support, which lets users share NewWave features.

Perhaps the most important feature of NewWave—and the hardest to describe adequately in a simple features list—is its support of objects.

NewWave has no data files as such. There are only objects, which are data files that have been linked to a NewWave application. One important type of object is a folder, which functions much like a Macintosh folder. It can contain other objects, and you

organize your desktop, or Office, as NewWave refers to it.

There are also no applications as such. What look like applications are really tools—specialized folders that store, print, or delete the objects dropped onto them.

Creating a new data file in NewWave involves an unusual process. For example, in Windows, you start a new spreadsheet data file by first clicking on the Excel icon and opening a new file. In NewWave, you instead select the menu command Create a New Object. A dialog box then asks you what type of object you want to create. You could then select a Lotus 1-2-3 object and give it a name. An icon for a Lotus object would then be displayed on the NewWave Office workspace. When you click on this application, NewWave will automatically load 1-2-3 and launch you into the data file you selected.

The most important capability of NewWave's objects is their ability to incorporate other objects. Unfortunately, only those objects that are linked with a small number of true NewWave applications have this capability. For example, NewWave Write, the NewWave version of the simple Windows Write word processor, can incorporate 1-2-3 objects, but 1-2-3 objects cannot incorporate other objects.

Since NewWave Write has the capability to incorporate other objects, it is actually a fairly impressive word processor. In a NewWave Write document, you can insert tables from 1-2-3, graphics from HP's optional DOS-based graphics programs, and simple annotations. And as more object types appear (made possible by new NewWave applications), NewWave Write will continue to acquire new capabilities.

Unfortunately, there's a dark side to NewWave. For one thing, the program is huge. It takes up about 7 megabytes of disk space and requires quite a long time to install.

NewWave also suffers from a lack of applications. Only a handful of programs now work well with it. Some sorely needed applications that HP would do well to add are NewWave versions of Windows Paintbrush or Terminal.

In some cases, the program could be markedly improved by simple additions. For example, you can incorporate 1-2-3 tables into NewWave Write documents, but you cannot change the font that the tables appear in. If you could change the font, NewWave could function as a nice complementary program for 1-2-3.

NewWave is a very interesting program, and it's available at an affordable price. It is probably true that someday all GUIs will be like it. But it needs a few more applications before it becomes a required day-to-day business tool.

—Rich Malloy



THE FACTS

NewWave 3.0
$195

Requirements:
IBM AT or compatible with a hard disk drive, a mouse, and Windows 3.0.

Hewlett-Packard
Santa Clara Information Systems Division
3410 Central Expy.
Santa Clara, CA 95051
(408) 749-9500
Inquiry 1162.

Peeking Through Windows

The original System Sleuth for DOS was a diagnostics package that snooped around your PC and told you all sorts of goodies about its configuration, including the microprocessor type, how much and what kind of memory was available, and the results of power-on self tests (POSTs). It also fished out a lot of esoteric but important data about I/O cards, hard disk drive partitions, device drivers, and TSR programs.

Moving the package to the Windows 3.0 environment, Dariana Technology Group confronted an interesting dilemma: When a PC runs in protected mode instead of real mode, a lot of nuts-and-bolts information about the computer becomes invisible or irrelevant. So what's left to diagnose?

Plenty, as it turns out. Dariana's new **WinSleuth** still delivers pages of data that can help you summarize your system's configuration, resolve board conflicts, or identify nagging software incompatibilities. Even without its diagnostic capabilities, the package might be indispensable for system administrators, who could print out and file a complete report about every system in their facility.

Gone from WinSleuth—when it is running in Windows standard or 386 enhanced modes—is the low-level data about memory allocation, disk drive partitions, and device drivers, since these are handled by Windows. If the package is run in Windows' real mode, however, more low-level information is provided, although some of it isn't relevant to the behavior of the system in protected mode.

What is gained in WinSleuth—aside from an attractive and very simple graphical user interface—is specific information about the Windows environment, including how it has allocated available memory, which drivers it is using to talk to your peripherals, and how it is managing tasks. The new release also adds a file viewer for peering into your hard disk and a new module for analyzing network connections.

The rest of the package is organized similarly to the DOS version, as a series of modules addressing different subsystems: microprocessor, POSTs, hard disk drive, video/display, RAM, I/O cards, printer, and DOS.

For example, the General Information section tells you what CPU you are using (although not the clock speed), if you have a math coprocessor, and how many and what kind of I/O ports and storage

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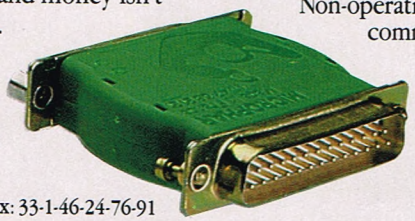
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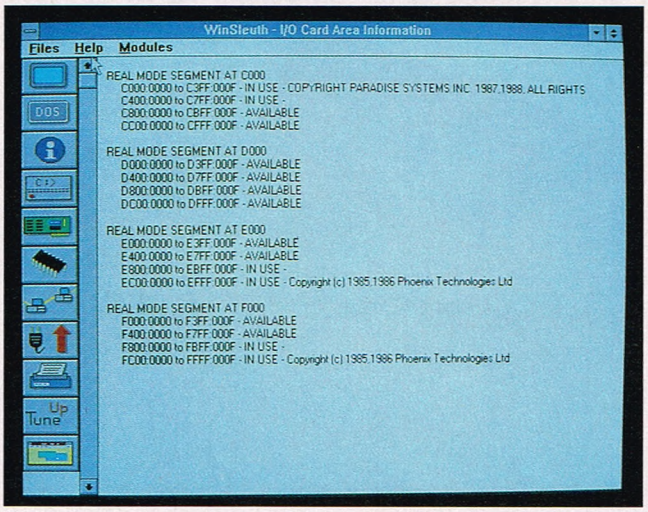
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peripherals are installed.

The modules affected by the difference between Windows modes include hard disk drive, DOS, and RAM. The hard disk drive module always tells you how many sectors and file allocation tables you have, but in real mode you can also see partition information. In real mode, the DOS module shows you device drivers and TSR programs. The RAM module, in 386 enhanced mode, gives you extensive information on memory allocation by the DOS Protected Mode Interface memory manager.

Perhaps the most useful features of WinSleuth are its help system and Windows Tune-Up module. The on-line help is like a short course on the inner workings of PCs and Windows; I recommend working your way through each topic. And if you need advice on getting the best performance out of your system under Windows, run the Tune-Up for suggestions that range from adding more RAM, to optimizing your hard disk drive, to removing conflicting extended memory managers.

—Andy Reinhardt



THE FACTS

WinSleuth
$149; $60 upgrade for System Sleuth owners

Requirements:
IBM PC or compatible with Windows 3.0.

Dariana Technology Group, Inc.
6945 Hermosa Cir.
Buena Park, CA 90620
(714) 994-7400
Inquiry 1163.

Could WordPerfect Rhymer Be Finer?

WordPerfect Corp. has come up with a truly unique writer's helper in **WordPerfect Rhymer**, a 93,000-word American English rhyming dictionary.

Rhymer is a tool for the student of the *sound* of language. A TSR program requiring 34K bytes of RAM, Rhymer searches for a variety of rhymes and phonetic patterns. It works with any DOS word processor.

Being a sucker for a good rhyme, I loaded Rhymer onto my hard disk. The program took up a mere half-megabyte of storage space, which was good news. The program worked fine with my word processor and my other TSR dictionary, neither of which carries the WordPerfect label.

To see whether Rhymer could determine which words have multiple pronunciations, I requested a triple rhyme for the word *interested*. The results were positive. Rhymer asked me to select between the pronunciations "in-tu-rus-ted" and "in-trus-tud" before beginning its rhyme search.

Although Rhymer isn't designed for regional U.S. dialects, it does include a phonetic finder to help you tailor your rhyme search to suit your speech patterns. This feature includes a phonetic chart—similar to a pronunciation key in the front of a dictionary—that lists a variety of sounds, including vowels, stops, fricatives, affricates, liquids, and glides. If your pronunciation of the word *car* sounds more like "cah," for example, you can instruct Rhymer to search for words with the <aw> vowel sound. And you can control the scope of your rhyme hunt by limiting the number of syllables and letters you want the program to search for.

I had just one major complaint about Rhymer: The program displays only 24 rhymes at once. Once you hit Enter to see additional rhymes, you can't go back to review the previous list. Since many words have dozens of rhymes, it would be helpful to be able to page through an entire list—much as you page through a word processing document. You can configure Rhymer to save all rhymes in a DOS text file, however, but you must first exit the program to view the list.

No doubt someone will eventually include a rhyming utility with a spelling/grammar checker program, or perhaps with an on-line dictionary, but until then, Rhymer is good enough for the rhymin' fool in all of us. ■

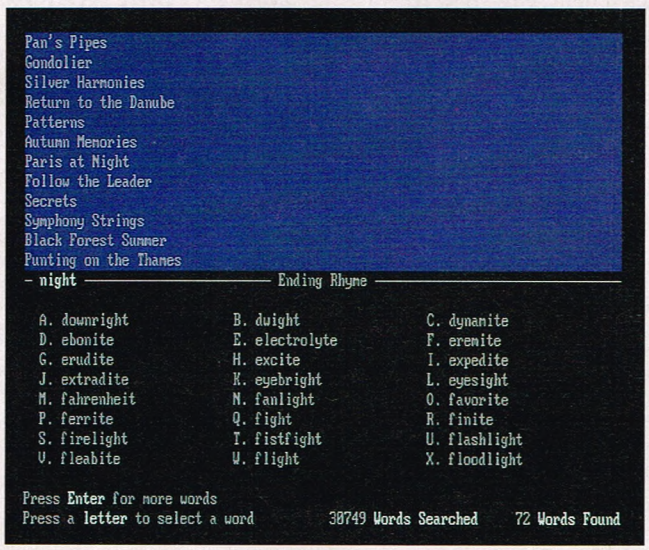
—Jeff Bertolucci

THE FACTS

WordPerfect Rhymer
$79

Requirements:
IBM PC or compatible.

WordPerfect Corp.
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Inquiry 1164.





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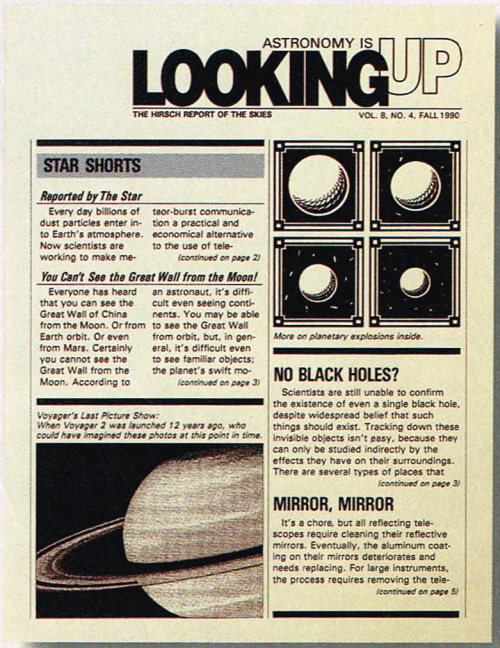
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If you think the HP LaserJet III is great,


ASTRONOMY IS
LOOKING UP
THE HIRSCH REPORT OF THE SKIES
VOL. 8, NO. 4, FALL 1990

STAR SHORTS

Reported by The Star

Every day billions of dust particles enter into Earth's atmosphere. Now scientists are working to make meteor-burst communication a practical and economical alternative to the use of tele- *(continued on page 2)*

You Can't See the Great Wall from the Moon!

Everyone has heard that you can see the Great Wall of China from the Moon. Or from Earth orbit. Or even from Mars. Certainly you cannot see the Great Wall from the Moon. According to an astronaut, it's difficult even seeing continents. You may be able to see the Great Wall from orbit, but, in general, it's difficult even to see familiar objects; the planet's swift mo- *(continued on page 3)*

More on planetary explosions inside.

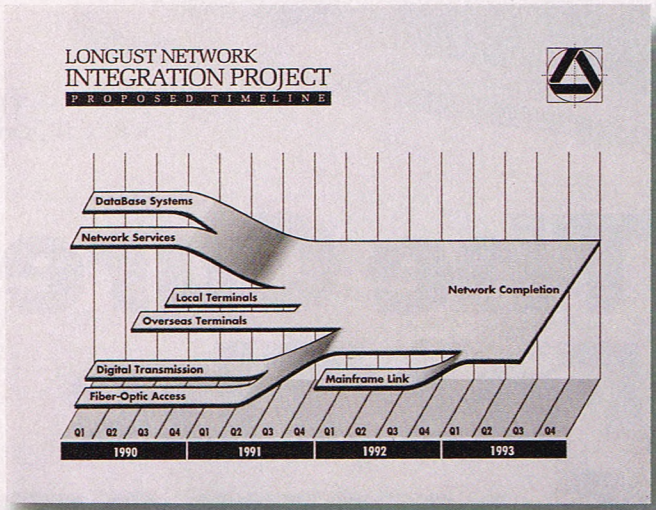
Voyager's Last Picture Show:
When Voyager 2 was launched 12 years ago, who could have imagined these photos at this point in time.

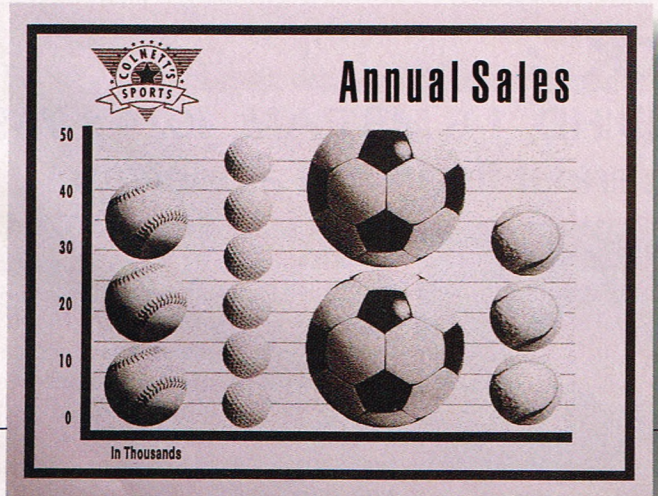
NO BLACK HOLES?

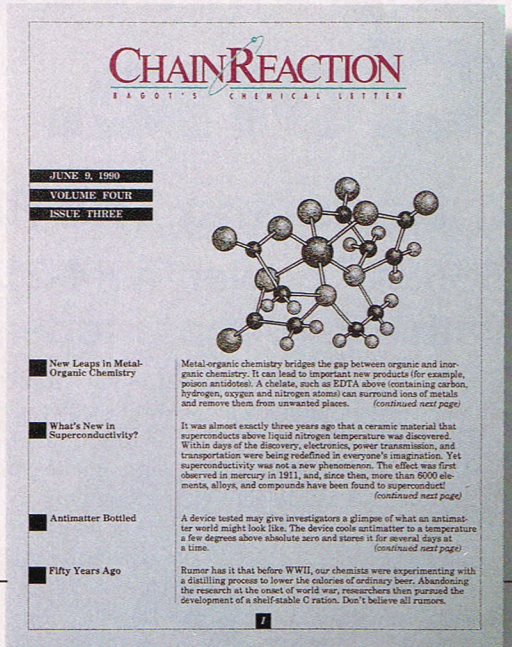
Scientists are still unable to confirm the existence of even a single black hole, despite widespread belief that such things should exist. Tracking down these invisible objects isn't easy, because they can only be studied indirectly by the effects they have on their surroundings. There are several types of places that *(continued on page 3)*

MIRROR, MIRROR

It's a chore, but all reflecting telescopes require cleaning their reflective mirrors. Eventually, the aluminum coating on their mirrors deteriorates and needs replacing. For large instruments, the process requires removing the tele- *(continued on page 5)*






CHAIN REACTION
BAGOT'S CHEMICAL LETTER

JUNE 9, 1990
VOLUME FOUR
ISSUE THREE

New Leaps in Metal-Organic Chemistry

Metal-organic chemistry bridges the gap between organic and inorganic chemistry. It can lead to important new products (for example, poison antidotes). A chelate, such as EDTA above (containing carbon, hydrogen, oxygen and nitrogen atoms) can surround ions of metals and remove them from unwanted places. *(continued next page)*

What's New in Superconductivity?

It was almost exactly three years ago that a ceramic material that superconducts above liquid nitrogen temperature was discovered. Within days of the discovery, electronics, power transmission, and transportation were being redefined in everyone's imagination. Yet superconductivity was not a new phenomenon. The effect was first observed in mercury in 1911, and, since then, more than 6000 elements, alloys, and compounds have been found to superconduct! *(continued next page)*

Antimatter Bottled

A device tested may give investigators a glimpse of what an antimatter world might look like. The device cools antimatter to a temperature a few degrees above absolute zero and stores it for several days at a time. *(continued next page)*

Fifty Years Ago

Rumor has it that before WWII, our chemists were experimenting with a distilling process to lower the calories of ordinary beer. Abandoning the research at the onset of world war, researchers then pursued the development of a shelf-stable C ration. Don't believe all rumors.

1

Introducing the new HP LaserJet IIID printer. The LaserJet that combines all of the advanced capabilities of the exciting LaserJet III with all of the paper-handling features required by today's busy office.

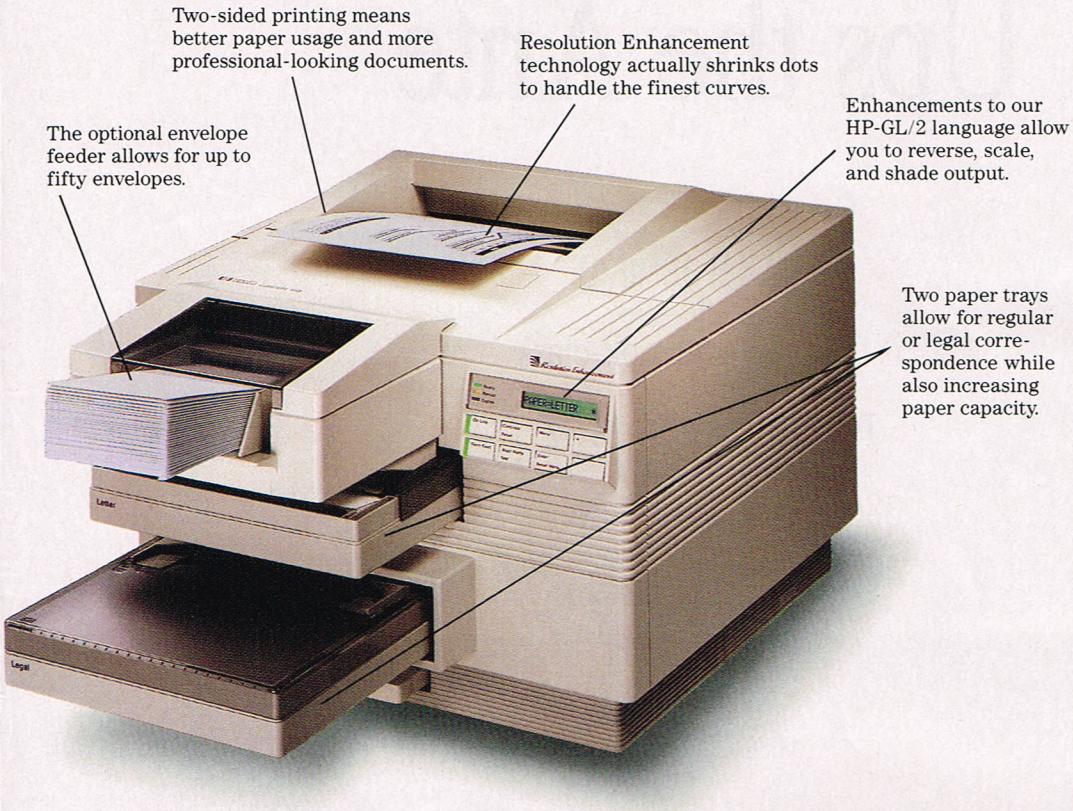
There's a lot to like. Like two paper trays for different types and sizes of paper. 200-sheet capacity in each of those trays for less reloading. And two-sided printing that lets you easily condense your output. Even an optional automatic envelope feeder that eliminates manual feeding.

Equally impressive is HP's Resolution Enhancement technology. Pioneered in the LaserJet III, this technology actually varies the sizes of dots. So curves really curve. Lines are never jagged. And you get resolution never before seen in a 300 dpi printer. Output has never looked so good.

Documents can be made even more elaborate thanks to our en-

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you'll automatically like the new HP LaserJet IIID.



hanced PCL5 printer language, which includes HP-GL/2 graphics language. You can print regular or reverse type. Shaded text. Even portrait and landscape on the same page.

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COVER STORY

Compaq Notebook Ups the Ante

The LTE 386s/20 is the first notebook-class PC that has a 20-MHz 386SX CPU and converts to a desktop system

■

Michael Nadeau

Take a Compaq Deskpro 386/20, give it a faster hard disk drive, and squeeze it into a 7½-pound notebook-size format, and you have the Compaq LTE 386s/20. Worried about expandability? No problem; Compaq will sell you a Desktop Expansion Base that provides AT-compatible slots and mass storage expansion options and allows the LTE 386s/20 to double as your desktop system.

The LTE 386s/20 is unique on two counts: It is the first notebook PC to use the 20-MHz 386SX CPU, and it is the only notebook PC that is convertible to desktop use. (At this writing, only a handful of other vendors have announced 16-MHz 386SX notebook PCs; none are shipping at this time.) In fact, it is the only notebook PC powerful enough to compete with the typical desktop systems that businesses are buying today (see photo 1). There is a catch, and that is the LTE 386s/20's price tag: $6499 for the base system; the Desktop Expansion Base is another $1499—not including a full-size keyboard or external monitor. (All prices mentioned are not final, but Compaq says prices will not exceed those listed here.)

The base system, the Model 30, comes standard with 2 megabytes of RAM, a 4K-byte RAM cache, a 3½-inch 1.44-MB floppy disk drive, a 2½-inch 30-MB Conner Peripherals hard disk drive, a 640- by 480-pixel VGA display, and system utilities. This version also comes with a full complement of I/O ports: one serial, one parallel, and one mouse port; ports for an external monitor, keyboard, and keypad; and an "external options interface."

The Model 60 comes with a 60-MB hard disk drive and lists at $6999. It will be the first system to use the 2½-inch drives of that capacity. Compaq called the unit that I saw an early prototype, although it appeared to be of production quality and seemed fully functional. The LTE 386s/20 should be out by late October.



Photo 1: *The Compaq LTE 386s/20 is arguably the world's most powerful 7-pound PC.*

LTE-Like in Looks Only

At first glance, the LTE 386s/20 is identical to the original LTE except for color; it is beige instead of gray. On closer inspection, you can see differences in drive location, thickness, port arrangement, screen size, and some cosmetic aspects.

Compaq has a totally new design for the electronics, which determined the placement of the drives. For the motherboard, the LTE 386s/20 uses a manufacturing technique developed for the aerospace industry. If you look inside the computer, you'll see what appears to be a three-piece motherboard—two boards, one on top of the other, and a third board mounted vertically at the rear and

PRELIMINARY BYTE BENCHMARK INDEXES: LTE 386S/20

The LTE 386s/20 is the fastest notebook-class PC that BYTE has benchmarked to date. It seems that Compaq simply shrank its Deskpro 386/20 and gave it a faster hard disk drive. The Dell 320LX is a 20-MHz 386SX desktop system included for comparison.

	CPU	Disk	Video
Compaq LTE 386s/20	2.58	2.32	8.00
Compaq Deskpro 386/20	2.58	1.72	8.21
Dell 320LX	2.19	1.86	7.10

Benchmark results are indexed to show relative performance; higher numbers indicate better performance. For all indexes, an 8-MHz IBM AT running MS-DOS 3.3 = 1.

PHOTOGRAPHY: PAUL AVIS © 1990

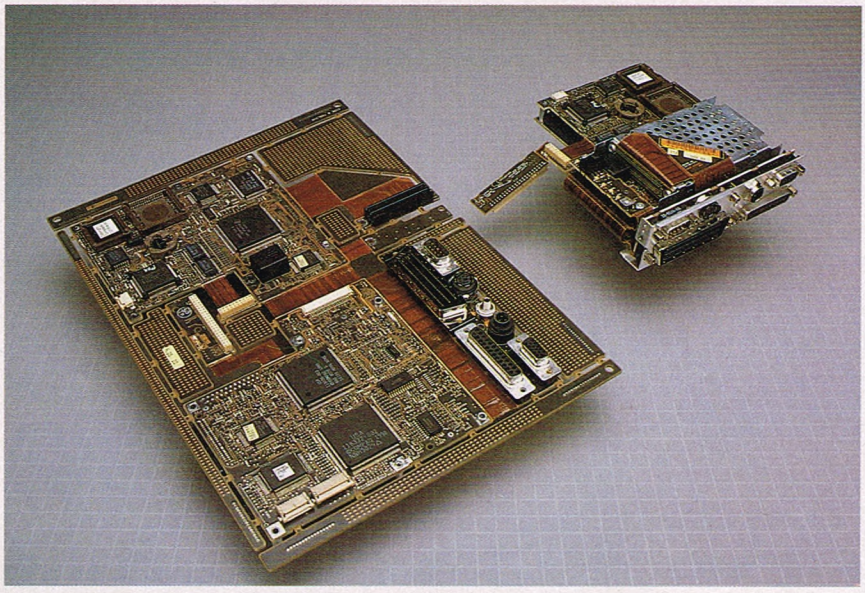


Photo 2: *On the left is the LTE 386s/20 motherboard before it is punched out from its silicon casing. On the right is the motherboard as it is installed in the computer.*

holding all the ports. These three components are manufactured as one sheet, connected by the cabling and thin silicon tabs. A machine "punches out" the motherboard along these tabs, and then, after the components are in place, it is folded by hand into its proper configuration (see photo 2). The procedure speeds assembly and helps conserve space inside the unit.

A major weakness of the original LTE was its CGA display with its less-than-perfect aspect ratio. Compaq saw the light and gave the LTE 386s/20 a full VGA display, although this added a smidgen to the unit's thickness. The screen is edge-lit and has good contrast and even light distribution.

All the ports congregate behind a sliding door (a nice touch) to accommodate the Desktop Expansion Base with its own I/O ports, which are extensions of those on the notebook. Unlike with the NEC ProSpeed SX/20 (see "The NEC ProSpeed SX/20: Take It and Leave It," September BYTE), you must maintain separate CONFIG.SYS and AUTOEXEC.BAT files for the portable and desktop configurations of the LTE 386s/20 (this is especially important if the desktop version is on a LAN), and you must remember to use the correct combination.

Unfortunately, no prototype of the Desktop Expansion Base was available for me to see. Its features include two full-size 16-bit expansion slots, monitor and keyboard ports, and two 5¼- or 3½-inch drive bays.

What has not changed on the LTE 386s/20 is the keyboard. It is the same 80-key IBM Enhanced–compatible layout. Key travel is somewhat less than what you find on desktop units, but the tactile feedback is adequate. I prefer the familiar inverted *T* arrangement for the cursor movement keys, rather than Compaq's cumbersome reclined *L* configuration.

Memory expansion makes use of the increasingly popular RAM cards. The LTE 386s/20 has two slots into which the credit-card-size RAM cards slide. Prices for the RAM cards, which come in 1-MB and 4-MB configurations, are $549 and $2599, respectively.

Compaq claims a battery life of about 3 hours. I didn't have the opportunity to verify that; it is about an hour less than the rated time for the original LTE. The LTE 386s/20 has a fast-charge feature built into the system that brings the battery back to full capacity in 1½ hours.

Early Assessment

The preliminary BYTE Lab low-level benchmark indexes place the LTE 386s/20 on a par with the Compaq Deskpro 386/20 in the CPU and video categories, but the notebook's speedier hard disk drive bests the Deskpro's index of 1.72, with a score of 2.32 (see the table). No other notebook-class PC even comes close to this performance. The LTE 386s/20 will run any software that you are likely to use, and at an acceptable pace.

The price will scare away casual users and many cash-conscious businesses, but the LTE 386s/20 seems to have what computing-dependent businesses need: power and flexibility. Compaq's reputation for high quality and compatibility further enhances the product. (Some of the original LTEs did have a problem with cracking cases; Compaq insists that it has solved that problem by going with a stronger plastic for the case.) But price aside, Compaq has produced the high-performance notebook PC against which all others will be compared. ■

Michael Nadeau is the managing editor of the BYTE Lab. You can reach him on BIX as "miken."

THE FACTS

Compaq LTE 386s/20 Model 30
No more than $6499

Compaq Computer Corp.
P.O. Box 692000
Houston, TX 77269
(713) 370-0670
Inquiry 1079.

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MaxxiCAD 1.02	$ 1,895.00	N/A
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MicroStation PC 3.0	$ 3,300.00	Customer Support Libraries $1,000.00
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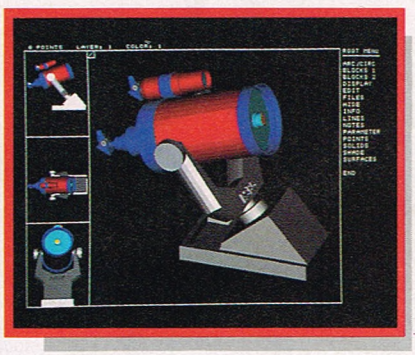
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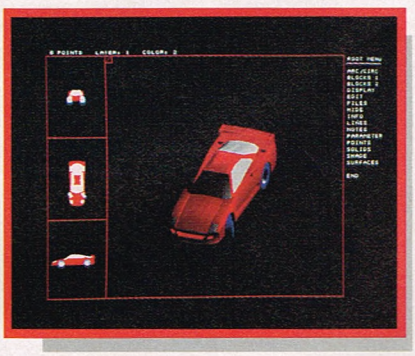
BYTE MAGAZINE SAYS...

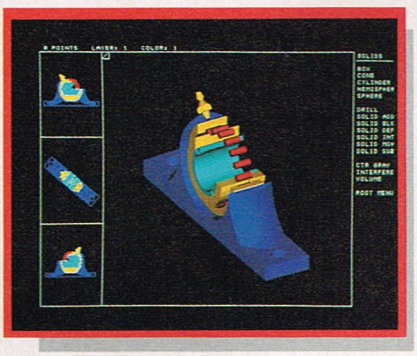
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May 1989, page 178

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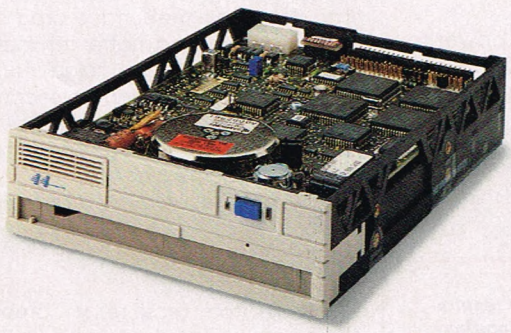
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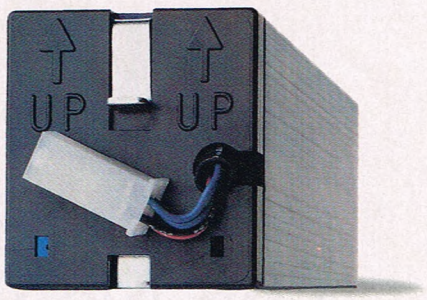
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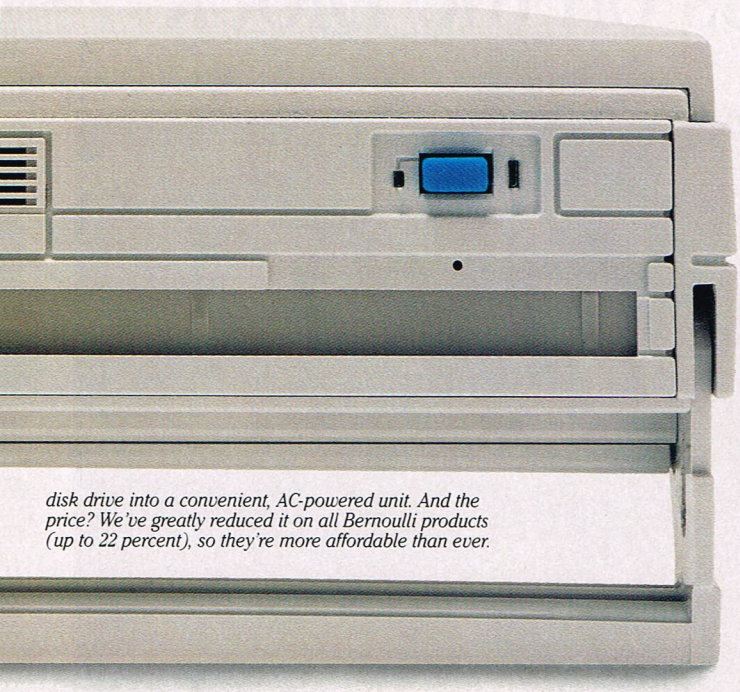


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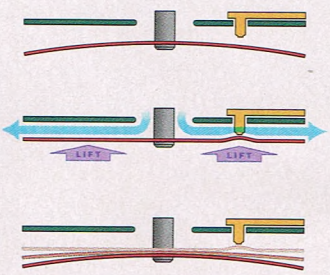
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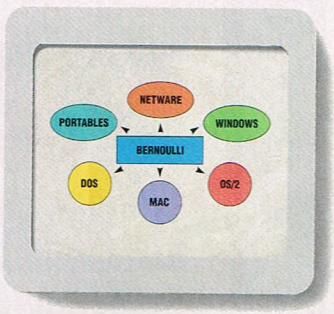


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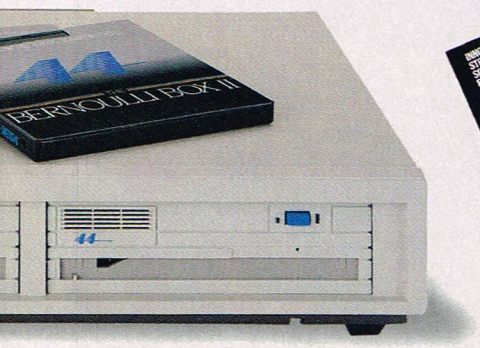
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The New Macs on the Block



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Apple's new systems feature lower prices and a new modular design

Although Apple has long been fond of calling the Macintosh "the computer for the rest of us," many potential Mac users have found the machines too expensive for their pocketbooks. Apple has long been criticized for being too expensive and for not being competitively priced against IBM PC–compatible computers. This criticism seems especially apt when you consider that, except for a brief trial period last year, no Mac has ever had a list price below $1000. Since Apple has no direct competition in its Macintosh product line, competitive pricing has never been its foremost concern.

Apple is hoping to change that image with its introduction of three new Macs. First is the long-awaited "Cheap Mac"—the new Mac Classic, which retails for $999 in its simplest configuration. For users who need color but can't afford a Mac II, Apple will be offering the new Mac LC for approximately $3000, including monitor. Finally, there's a new member of the Mac II family, the Mac IIsi, priced at $4870 including monitor.

Apple is trying to make a point with these systems. A Mac always comes with enough features to let you get to work immediately and productively with a range of applications. Features that are options on IBM PC–compatible systems are built in on the Mac (e.g., networking, digitized sound, and a graphical user environment). Apple has also tried wherever possible to make these systems ready for the future—ready, specifically, for the forthcoming System 7.0 software. The only exception to this is the basic Classic configuration, which will require additional memory.

The Mac Classic

The Mac Classic represents a complete overhaul of the lowest end of Apple's current product line. Essentially, it is the hardware soul of the Mac SE at less than the price of a Mac Plus. The Classic comes in two configurations: a low-end model that includes 1 megabyte of 120-nanosecond RAM and a SuperDrive floppy disk drive for $999; and a $1499 model with 2 MB of RAM and a fast (21-ms average access time) 40-MB hard disk drive. The street price of the low-end Classic might go below $700, while the high-end model's might dip to $1000.



Externally, the Classic closely resembles the SE. There are some minor cosmetic differences, but the familiar upright chassis with the built-in black-and-white 9-inch monitor remains the same. The system also remains relatively easy to carry around, for a desktop system. The high-end model weighs in at 17 pounds, only 1 pound more than a Mac Portable.

The Classic uses a single Apple Desktop Bus (ADB) port and two mini-DIN-8 connectors for the serial ports. In contrast, the Mac Plus used a unique keyboard and keyboard connector, and DB-9 connectors for the serial ports. Unlike with previous Macintosh systems, the keyboard is included in the price of the Classic.

Other I/O ports include a DB-25 SCSI port, an external speaker port, and the external floppy disk drive port for 800K-byte or 1.4-MB disks. The Classic's internal hard disk drive is considerably faster than the hard disk drives currently available from Apple for the SE.

The Classic's system board has been completely redesigned with lower cost in mind. It is only 60 percent of the size of the SE's system board. Apple put a great deal of effort into integrating as many functions as possible into custom application-specific ICs and into laying the board out optimally. One example of the improvements achieved in this way is a smaller and lighter power supply that powers both the Classic's main system and its monitor. In contrast, the SE uses

New Mac Lineup

By January 1991, when the Mac LC becomes available, Apple's Macintosh lineup will contain the following systems:

PORTABLE FAMILY
Mac Portable

COMPACT FAMILY
Mac Classic
Mac SE/30

"LC" FAMILY
Mac LC

MODULAR FAMILY
Mac IIsi
Mac IIx
Mac IIci
Mac IIfx

New Prices for Existing Macs

Mac IIci
with 4 MB of RAM and a floppy disk drive:
$5969

Mac IIci
with 4 MB of RAM and an 80-MB hard disk drive:
$6669

Mac SE/30
with 1 MB of RAM and a 40-MB hard disk drive:
$3369

Mac SE/30
with 4 MB of RAM and an 80-MB hard disk drive:
$4569

two separate supplies: one to power the digital board, and another to power the analog circuits that drive the monitor. The Classic's fan mounts at the bottom of the unit for cooling efficiency and is extremely quiet.

Like the SE, the Classic uses an 8-MHz 68000. Memory is expandable to a maximum of 4 MB by adding 120-ns single in-line memory modules. You add this memory by inserting a small card that has 1 MB of RAM on it and two SIMM sockets.

Like those of its predecessors, the Classic's video buffer is in main RAM. While this simplifies the Classic's design (as it did the Mac Plus and SE's), there's a 25 percent performance penalty for bus bandwidth when RAM used for video is accessed to refresh the screen. The Classic should be as fast as an SE and 25 percent faster than a Plus.

The Classic has 512K bytes of ROM, twice the size of the SE's ROM. This ROM incorporates the Hierarchical File System and drivers for SCSI, ADB, AppleTalk, the Toolbox, and QuickDraw.

Where the Classic more closely resembles the Mac Plus than the SE is in its lack of an internal expansion slot. This was a cost/design trade-off. Leaving out the slot was a way to save money on the Classic's design, and Apple's research indicated that 90 percent of users wouldn't be interested in expansion capabilities. You could expand the system by way of its SCSI bus, but it will be hard to add accelerators or large external monitors.

The Classic will ship with the newest revision of System software, version 6.0.6, although it will work with version 6.0.5. The Classic was, however, designed with System 7.0 in mind. The high-end model is System 7.0–ready, while the low-end model only requires an additional megabyte of RAM. Although the Classic cannot make use of it, System 6.0.6 includes the new Sound Manager with its sound input capabilities.

Apple is going to discontinue both the Mac Plus and the SE, since it believes that the Classic is a good replacement for both. Those in the market for either a Plus or an SE will be better off with a Classic instead. (This includes university students or anybody who wants a "transportable Mac" for an occasional journey.) According to Apple, retaining the small, all-in-one footprint of the original Mac is important for the low-end market.

The preliminary BYTE benchmark results (see the table) indicate that the Classic is—no surprise here—on a par with the SE in performance.

MAC CLASSIC BENCHMARK RESULTS

Preliminary BYTE benchmark results (in seconds) for the new Mac Classic suggest that it performs at about the same speed as the older Mac SE. The Classic turned in an appreciably slower time on two of the tests, but this could be due to problems with the early prototype we used. The prototype system we tested had 2 MB of RAM and a 40-MB hard disk drive.

Test	Mac Classic	Mac SE
CPU		
Matrix	77.22*	67.10
String move		
Byte-wide	374.73	374.50
Word-wide	187.38	186.70
Doubleword-wide	121.73*	92.40
Sort	154.53	154.20
Sieve	170.83	170.20
Disk I/O		
1-megabyte write	6.63	14.80
1-megabyte read	4.38	8.10
Video Text		
Text		
TextEdit	16.35	15.10
DrawString	3.85	3.80
Graphics		
Slow test	88.28	84.40
QuickDraw	1.22	1.10

* Possible benchmark error.

For a full description of the Mac benchmarks, see "Introducing the New BYTE Benchmarks," June 1988 BYTE.

Mac LC:

Low-Cost Color in a New Box

The Mac LC is Apple's "lowest-cost color-capable computer"—hence the name. This system is intended to fill the void between the SE/30 and the IIx line. The LC will be offered for a complete system price of $3000, including keyboard (the same compact keyboard that comes with the Classic), hard disk drive, and color monitor.

The LC also represents a new design shape for Apple. It is similar to Sun's "pizza box" workstation, but in a different, smaller size. The case is a flat box shape, measuring 12⅕ inches wide by 15 inches deep by 3 inches high. It weighs 8⅘ pounds. The front of the case, which is similar in style to the Mac II line, has a SuperDrive floppy disk drive on the right. On the back are seven ports: a video port, a printer port, a modem port, a SCSI connector, an ADB connector, a sound-out port, and a sound-in port. The last two provide the LC with built-in complete sound-processing capabilities.

With only 24 chips, the LC's logic board represents a high level of integration that helps reduce costs (see photo 1). The LC uses a 16-MHz 68020 CPU and has built-in video logic like the Mac IIci. The system comes standard with 2 MB of 100-ns fast paged-mode soldered RAM, expandable to 10 MB in two SIMM sockets. There is no FPU, and no socket for one. The 512K-byte ROM includes 32-Bit Color QuickDraw. The system uses a 40-MB internal SCSI hard disk drive.

The LC's built-in video supports three monitors. One is Apple's existing 13-inch 640- by 480-pixel color monitor. Another is a 12-inch 640- by 480-pixel monochrome monitor, a basic redesign of the existing 12-inch monochrome monitor that makes it cheaper to produce while improving the picture quality.

Finally, a new color monitor, the Macintosh 12-inch RGB Display, provides a 512- by 384-pixel display. This new monitor was designed because Apple thought that existing color monitors didn't provide a sufficiently good picture with low-resolution 8-bit color and were too expensive. Thus, the new monitor has a smaller screen that displays 8-bit and 16-bit color crisply and clearly.

The LC uses 512K bytes of video RAM on the main logic board as the video frame buffer. With this frame buffer, you get 16 colors or gray scales on the 640- by 480-pixel monitors and 256 colors on the 12-inch RGB monitor. You can expand the buffer by plugging 512K bytes of additional VRAM into SIMM sockets. At the maximum frame buffer size, the LC can get 256 colors or gray scales on the larger displays, 16-bit color (over 32,000 colors) on the new 12-inch RGB monitor, and 256 gray scales on the 12-inch monochrome monitor.



The LC also includes one expansion slot, a 68020 Direct Slot. This slot is similar to the 68030 Direct Slot on the SE/30 and allows direct access to the CPU bus. However, the LC's 68020 Direct Slot is not compatible with the SE/30's 68030 Direct Slot. Because the LC doesn't have a socket for a paged memory management unit, one possible use of this Direct Slot might be to add a 68030 processor board to make use of the virtual memory technology in System 7.0. Apple also plans to introduce an Ethernet board for under $400 and an Apple IIe compatibility board that will cost less than $250. The latter unit would let the LC run Apple IIe software at full speed and would provide support for Apple IIe peripherals. For example, with a IIe

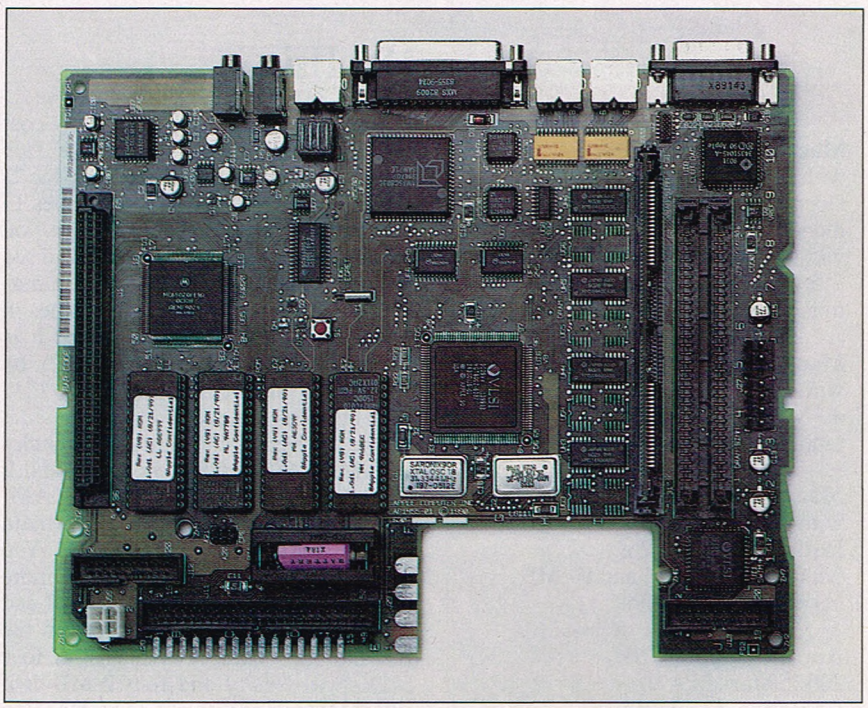


Photo 1: *The Mac LC's logic board has a low component count due to the high level of logic integration. On the left edge is the 68020 Direct Slot; near the right edge are the SIMM sockets for RAM and the SIMM-mounted ROM.*

compatibility board, an LC mouse emulates an Apple II mouse.

Why the Apple IIe compatibility? Apple sees the LC as tapping into the education markets. With a retail price of $3000 for a complete system, the LC might appeal to schools that currently use Apple IIs, especially since Apple is also planning to make single and dual floppy disk drive versions of this system available at a lower price to the educational market only.

Apple says that the LC has the same computing power as a 16-MHz 386SX system and is comparable in price to SX systems from IBM and Compaq; the company admits, though, that PC clone makers offer complete SX/VGA systems for far less than the LC's $3000 retail price. The LC with 2 MB of RAM and an internal 40-MB hard disk drive will cost approximately $2400. With the new 12-inch RGB color monitor costing $600, it is possible to get a color Macintosh system for $3000. The 12-inch monochrome monitor costs $300, so a usable LC system could actually be purchased for as little as $2700. The street price of a color LC will probably be around $2300 to $2400, making it competitive with high-end 386SX machines from major manufacturers.

Unfortunately, the Mac LC will not be available until January 1991. It is being manufactured at Apple's facilities in Singapore. This delay means that the prices of reasonably competitive IBM PC–compatible systems might fall still further before the LC is released.



Mac IIsi:

Lower Cost, More Options

The Mac IIsi is Apple's new low-cost Mac II. Designed to replace the IIcx (currently Apple's most popular Mac II model), the IIsi has some big shoes to fill. To fully appreciate the new IIsi, you must first compare it with the IIcx to see the differences between the two machines. The 10-pound Mac IIsi comes in a slimmer, smaller box (although it is larger than the pizza-box-shaped LC). Its dimensions are 4 inches high by 12½ wide by 15 inches deep.

The IIsi's basic configuration includes a 20-MHz 68030 CPU, no FPU, and 2 MB of 100-ns, fast paged-mode RAM. One MB of RAM is on the IIsi's main logic board; the other is on a SIMM. You can add up to 16 MB by installing more SIMMs. Apple is introducing 2-MB and 8-MB memory-expansion kits for the IIsi and IIci. These kits consist of four 512K-byte-density and four 2-MB-density SIMMs, respectively. (The Mac IIfx uses nonstandard 64-pin SIMMs, so it cannot use the new expansion kits.)

The IIsi includes eight built-in ports: an ADB port, a SCSI port, an external disk drive port, two serial ports, a video port, one stereo sound output port, and the new sound input port. Interestingly, the IIsi has a single expansion connector that can be set up as either a NuBus slot or a 68030 Direct Slot. This trick is accomplished by special adapters (sold separately for $200) that attach to the connector and provide a slot that's parallel to the system board. Through this maneuver, a NuBus board can fit inside the IIsi's smaller housing. Both adapters also provide a 68882 FPU. Why only one expansion slot? Apple claims that most Mac II users have only one board in their machines anyway—usually a video board. So Apple added built-in video to the IIsi system board, leaving the expansion slot open for more esoteric options.

Like the new Classic and the LC, the IIsi offers tight logic-board integration (see photo 2). The board is three-quarters the size of the IIcx board. Apple is able to offer the IIsi for $2200 less than the IIcx by removing much of the original system logic from the main logic board and by limiting expansion capabilities and making them an option. Despite the size reduction, however, the IIsi offers the same performance as the IIcx and includes many features that the IIcx doesn't have, including built-in 8-bit color video and support for 32-Bit Color QuickDraw in ROM. (The IIsi can generate 24-bit color video by using a 24-bit video board in a NuBus slot adapter.) The IIsi logic board now includes a ROM SIMM socket to simplify future firmware upgrades (the IIcx's ROM chips were soldered to the main logic board). The machine's 512K bytes of ROM includes 32-bit memory support.

Sound Investment

This brings us to one of the most interesting features on both the LC and the IIsi: built-in sound input. Apple sees sound as a natural extension to the Mac platform.

THE FACTS

Mac Classic
with keyboard, 1 MB of RAM, floppy disk drive, and built-in monochrome monitor, $999;
with keyboard, 2 MB of RAM, 40-MB hard disk drive, and monochrome monitor, $1499

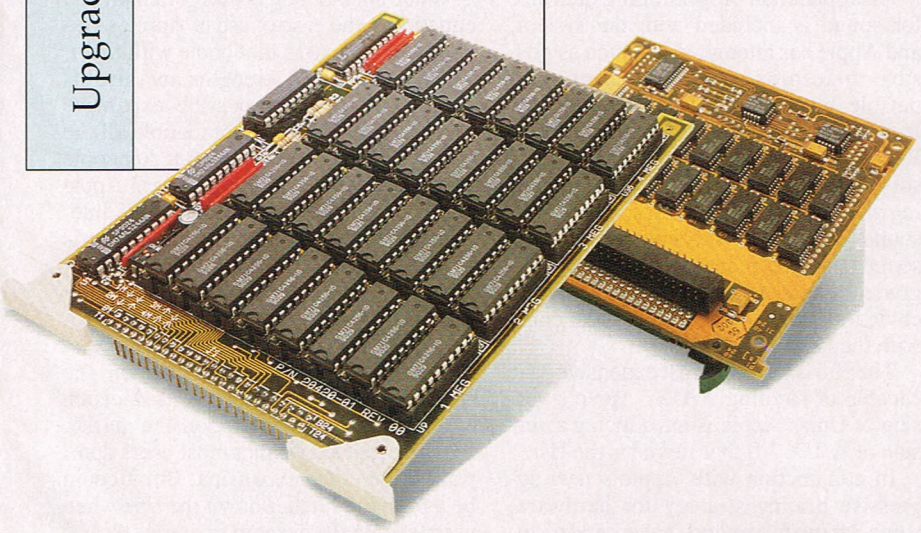
Mac LC
with keyboard, 2 MB of RAM, and 40-MB hard disk drive, $2400 (approximate)

Mac IIsi
with 2 MB of RAM and 40-MB hard disk drive, $3769;
with 5 MB of RAM and 80-MB hard disk drive, $4569

Apple Computer, Inc.
20525 Mariani Ave.
Cupertino, CA 95014
(408) 996-1010
Inquiry 1080.

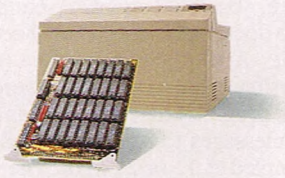
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	Pacific Data Products	Hewlett-Packard
Price	1 MB /$199 2 MB /$299 4 MB /$499	1 MB /$495 2 MB /$740 4 MB /Not Available
Warranty	Lifetime	One Year
Upgradeability	Fully Upgradeable to 4 MB	Not Upgradeable



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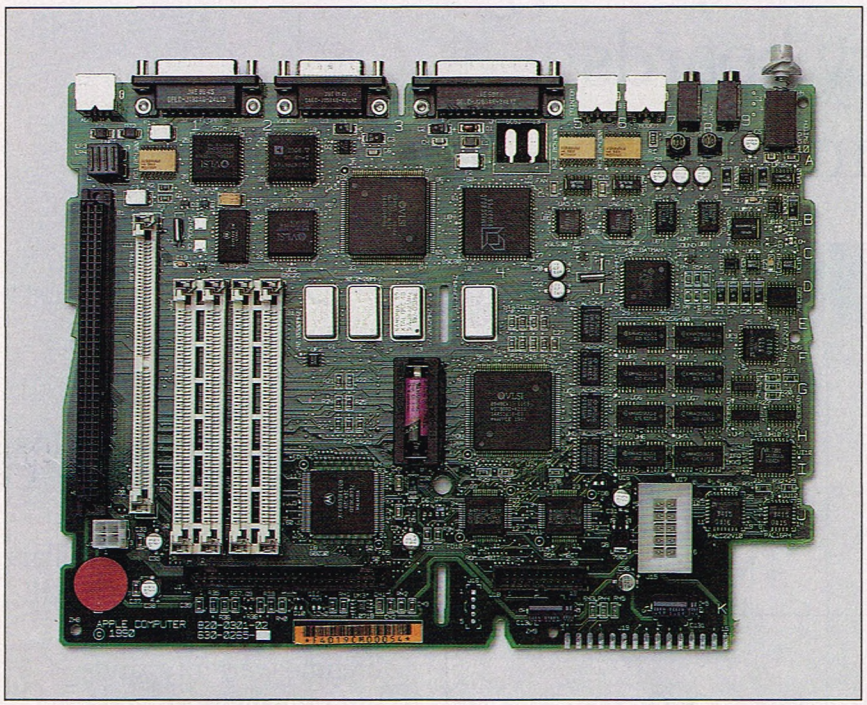


Photo 2: *The Mac IIsi board combines on-board video and support for either a NuBus slot or a 68030 Direct Slot via a special adapter. This adapter plugs into the connector on the board's left edge. By the connector is one socket for SIMM-mounted ROM and four SIMM-mounted RAM sockets. At the center are crystal oscillators for the on-board video and bus clock. The sound I/O jacks are at the upper right.*

Both the IIsi and the LC come bundled with an Apple electret microphone and phono jack. The microphone is a simple, button-shaped device (roughly the size of a silver dollar) that offers 8-bit monaural sound. It's a simple, omnidirectional microphone for recording messages; you can clip it to your clothing or place it on top of the Mac monitor. The sound input is via a standard phono adapter jack, so alternative microphones or other audio devices can be used.

One problem with the new microphone is that it connects to the back of the Mac box; a keyboard-based port for the mike would have been far more convenient. The NeXT Computer, for example, has a sound input port on its monitor stand.

With these devices and the appropriate software, you could annotate sound messages to documents and spreadsheets, for example. Apple demonstrated a pre-alpha version of an Ashton-Tate word processing program that lets you annotate sound messages to a document. Sounds are sampled at 11 or 22 kHz. The sound is filtered through a custom filter/preamplifier chip, converted to digital form, and stored in memory or directly on the hard disk. Also included is the Macintosh Audio Compression Expansion sound utility, which compresses sounds at ratios of 3 to 1 or 6 to 1. MACE lets you store up to 3 hours of sound on a 40-MB hard disk. The new sound capabilities do not include stereo sound.

An application programming interface for sound is included with the system, and Apple has attempted as much as possible to keep its sound extensions compatible with existing sound products from third parties, like Farallon's MacRecorder. The Control Panel desk accessory now has sound capabilities, including the ability to record your own alert sounds to replace the standard system sounds. Apple plans to eventually upgrade the rest of the Mac II family to include the same sound features that come with the IIsi and LC.

The IIsi is also the least expensive Mac capable of running A/UX, Apple's version of Unix: Apple is introducing a version of A/UX 2.0 that supports the IIsi.

In conjunction with Apple's new aggressive pricing strategy for hardware, some software vendors have banded together to provide a low-cost software solution for Apple users. A bundle consisting of WriteNow 2.2, SuperPaint 2.0, Full Impact 1.1, and Record Holder Plus will retail for $349.

The IIsi is available now. The standard configuration with 2 MB of RAM and a 40-MB hard disk drive is $3769. Add an Apple high-resolution monitor and the standard keyboard, and the price jumps to $4869. The IIsi minus monitor and keyboard and with 5 MB of RAM and an 80-MB hard disk drive will be $4569. (As with other Mac IIs, the buyer must choose between the standard or extra-large keyboard. However, as mentioned earlier, the keyboard comes bundled with the new Classic and LC systems.) Apple thinks the street price for a barebones IIsi, including monitor and keyboard, could drop to around $3600.

Apple Gets Price Wise

Along with introducing the new models, Apple is discontinuing three Macs. The Mac Plus and SE are being replaced by the Classic, and the IIcx by the IIsi. And to prove it's serious about its new competitive image, Apple has reduced the prices of existing IIci and SE/30 configurations.

Apple's goal with its new Macs and lower prices is to reach more people by increasing unit sales and market share. Indeed, the pricing of the new Macs is competitive, and Apple has a leaner, meaner desktop lineup these days. The new Macs offer impressive features for their price, and Apple should attract a lot of new customers. However, if viewed from a strict price-per-raw-computing-performance perspective, these systems still don't match up with the lower-cost IBM PC compatibles.

What should not be forgotten in the equation is the ease of use of Apple's systems and the extras that come with them. These are Apple's strengths and also its Achilles' heel. It is impossibly expensive to add into an IBM PC compatible all the extras that Apple provides. But do people want these extras or ease of use? Apple still has to persuade buyers that the integrated philosophy behind its systems is best. The new systems and prices just make this task a lot easier.

Probably the biggest drawback of Apple's new low-price systems is the relative lack of expansion options on the cheaper Macs. Apple based its decision to leave out expansion options on market research that shows that most users don't want or need the expansion. But it could be a problem farther down the line when users eventually want to upgrade. ■

Owen Linderholm is a BYTE news editor in San Francisco. He can be reached on BIX as "owenl." Jeff Bertolucci is a BYTE associate news editor in San Francisco. He can be reached on BIX as "bertolucci."



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A New Status Quo for Quattro

Andrew Reinhardt

The newest version of Borland's spreadsheet features 3-D graphics and a simple solver

Dislodging an entrenched market leader like Lotus 1-2-3 requires rivals to produce software that is fundamentally a better deal. With a new version of its popular Quattro Pro spreadsheet, Borland International continues to achieve just that: Quattro Pro 2.0 offers an expanded set of features over the previous version, while maintaining the advantages it already enjoyed over 1-2-3.

Quattro Pro provides more features and better performance than 1-2-3—and at a lower price—yet it will run on any DOS machine (e.g., an 8088-based XT with 512K bytes of RAM). Quattro Pro does not use the multilayered "three-dimensional" architecture of 1-2-3 release 3.0 (nor can it read Lotus .WK3 files), but it does offer a reasonable alternative: easy spreadsheet linking and the ability to have several spreadsheets stacked or tiled on the screen at once.

The ability to run comfortably in conventional DOS memory (by comparison, 1-2-3 release 3.0 requires 1 megabyte of installed RAM and uses a built-in DOS extender) is due to Borland's Virtual Real-Time Object-Oriented Memory Management architecture, a technique that breaks the program code into small chunks that are swapped in and out of memory as needed. VROOMM's efficient memory management makes it possible to load larger spreadsheets in conventional RAM than is possible under 1-2-3 release 2.2. And for very large spreadsheets, Quattro Pro supports up to 8 MB of EMS 4.0 memory.

Aside from its speed and small memory needs, the main advantages of Quattro Pro are superior graphics and spreadsheet publishing. For example, it comes with a Graph Annotator. This is a graphics program that is as sophisticated as the 1-2-3/G Graph Tool and is easier to use. You can also mix data and live charts on the same worksheet.

These capabilities have been enhanced with four new 3-D graph types (i.e., bars, step, area, and ribbon) and faster LaserJet drivers that support downloadable Bitstream fonts. Quattro Pro also now offers a 132-column mode (on EGA/VGA cards that support extended character sets), so you can view 12 months of a budget calculation on one screen.

However, Quattro Pro does have one important drawback compared with release 3.1 of 1-2-3: The Lotus spreadsheet now has a WYSIWYG mode that shows fonts and other graphical attributes on-screen as they will appear in printed output. By contrast, Quattro Pro will show colors, boxes, shading, and graphs, but not fonts.



Quattro Pro lets you display multiple, linked worksheets and live graphics on the screen at the same time.

Interactive Slide Shows

One of the most distinctive capabilities of Quattro Pro is the ProShow presentation

tool, which lets you create slide shows using spreadsheet data, graphs, and text. In version 2.0, ProShow presentations can become interactive and nonlinear: By clicking on "graph buttons" added to the screen, you can branch to other graphics or run macros.

Because ProShow is integrated into Quattro Pro, it can be an easier way to create presentations than exporting worksheets and graphics to a slide-show package (especially when the data is frequently updated), but it's not as graphically rich as Microsoft PowerPoint.

Quattro Pro 2.0 also adds a capability unmatched in any DOS-based spreadsheet: a Solve For tool that is similar to the Backsolver utility that is found in 1-2-3/G. Both Solve For and Backsolver can tweak a single input variable to produce a specified result, sparing you from trial-and-error goal seeking. However, Solve For doesn't match the power of the full 1-2-3/G Solver, which uses separate OS/2 threads to jiggle multiple factors constrained by numerous criteria.

Finally, Quattro Pro has added better support for networking, file import/export, and data access. It offers more printer drivers and graphics import/export formats, as well as a choice of international character sets with correct sorting for non-English text.

Quattro Pro now works better with Lotus 1-2-3. Release 2.2 files can be read into Quattro Pro with their cell-linking attributes preserved.

For networked installations, Quattro Pro 2.0 permits a single, shared set of large font files to reside on the server, saving disk space. The software includes user license management, which automatically monitors the number of simultaneous users of the program on a LAN.

And for spreadsheet users who want to access Structured Query Language databases, Borland has strengthened the ties between Quattro Pro, Paradox 3.5, and the Paradox SQL Link, which talks to SQL Server, IBM OS/2 Extended Edition, and Oracle Server. Now, if you have at least a 286 machine and 2 MB of RAM, you can load both Quattro Pro and Paradox, toggle between them with a hot key, and easily load Paradox or SQL data tables into a Quattro Pro spreadsheet for analysis or graphics.

In the interest of compatibility with industry-standard 1-2-3, you still have a choice of user interfaces: the 1-2-3 menu tree or a Common User Access–compliant pull-down Quattro menu tree. Having Lotus menus available is a comfortable fallback for those users bred on 1-2-3, but the Quattro menus are actually more efficient and easier to use. Borland is now the target of a lawsuit by Lotus for allegedly copying the look and feel of 1-2-3, but even without 1-2-3 menus, Quattro Pro would be a snap to learn for any experienced spreadsheet user.

One Size Fits All

Perhaps the most important point in Quattro Pro's favor is that while most of its features are available in some release of 1-2-3 (i.e., release 2.2 with the Allways add-in, release 3.1 with the Impress add-in, or 1-2-3/G for OS/2–Presentation Manager), no one package has them all.

In fact, the various releases of 1-2-3 are starting to get quite confusing for customers and technical-support personnel: The releases are segmented by hardware platform, each offers features the others lack, and they all use different commands and file formats for their presentation and publishing modules.

Quattro Pro, on the other hand, runs on any DOS platform with the same set of features. If you have a large investment in 1-2-3 data files, a lot of older-generation PCs, and a desire to tap into the latest spreadsheet capabilities, Quattro Pro is probably your best answer. ■

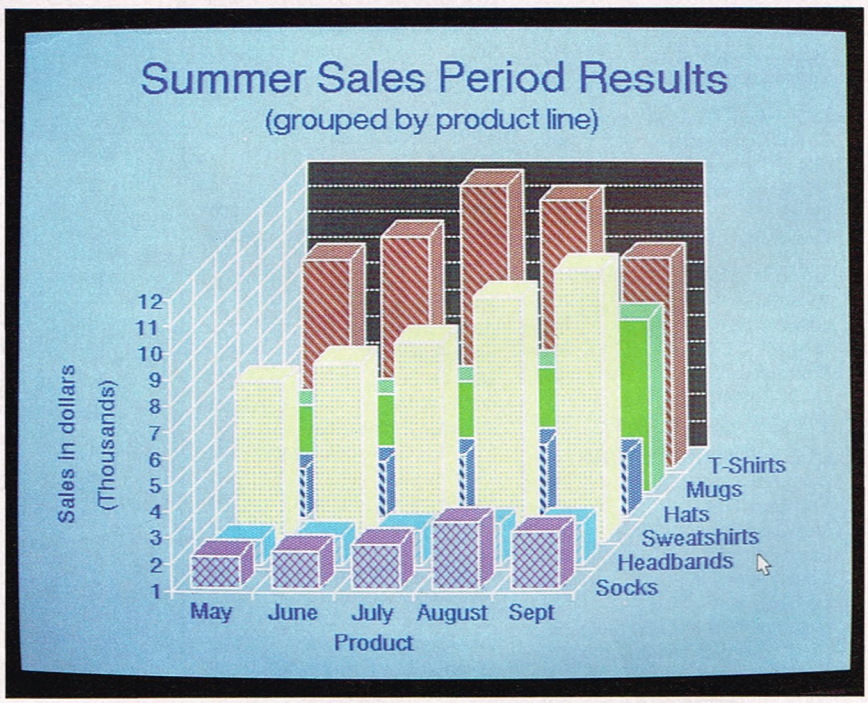
Andrew Reinhardt is BYTE's associate news editor in New York City. He can be reached on BIX as "areinhardt."

COMPANY INFORMATION

Quattro Pro 2.0
$495

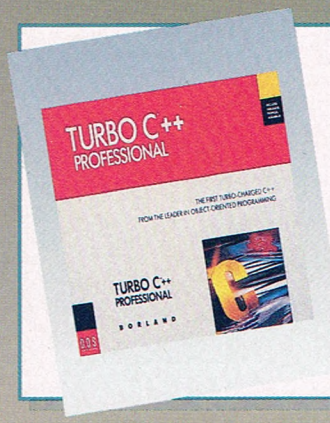
Requirements:
IBM XT or compatible with a hard disk drive and 512K bytes of RAM.

Borland International, Inc.
1800 Green Hills Rd.
P.O. Box 660001
Scotts Valley, CA 95066
(408) 438-8400
Inquiry 1166.



The new release of Quattro Pro supports 3-D bar charts (above), as well as 3-D ribbons, steps, and area plots.

Professional developers require



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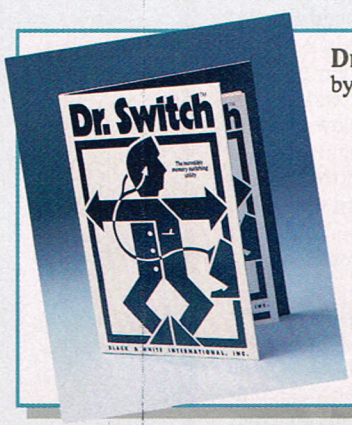
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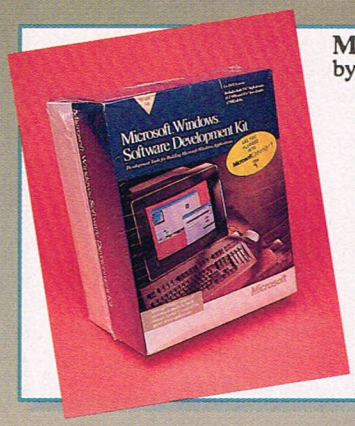
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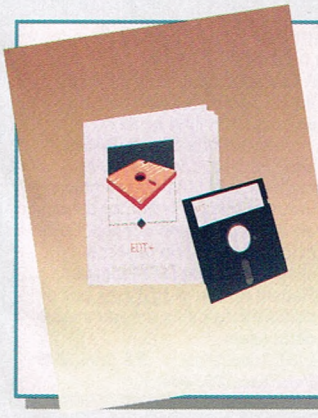
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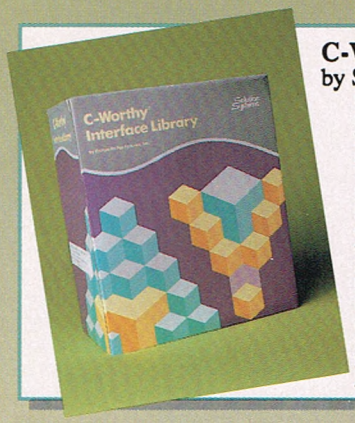
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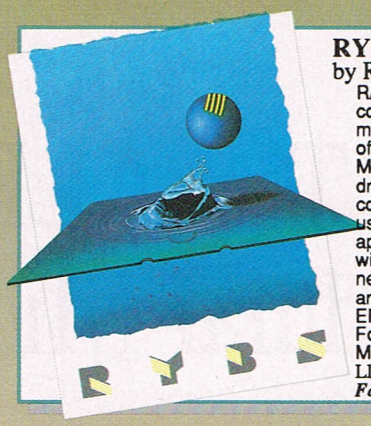
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The ALR MPS: Modular Micro Channel

Advanced Logic Research gambles that it can take a byte out of the True Blue market

Stan Miastkowski



PHOTOGRAPHY: PAUL AVIS © 1990

Just when you thought you had a handle on all those computer terms, here's another acronym for you: MPS. It stands for Modular Personal System, and it's Advanced Logic Research's latest PC incarnation on the way to that ever-elusive system nirvana.

ALR has carved out a solitary and comfortable nitch for itself with well-built systems notable for their easy-to-upgrade processor cards. It started off last year with the 286-based PowerFlex and kept the industry hopping earlier this year with the PowerVEISA, a 386-based machine with the Extended Industry Standard Architecture (EISA) bus.

With "Logic" in your corporate moniker, I guess you make logical business decisions. So it's no surprise that the latest ALR machine has taken the "logical" step of jumping headfirst into the Micro Channel market. The ALR MPS is essentially a nicely built PS/2 clone (see photo 1) that offers several features that Big Blue's entries do not, such as truly easy upgrade. A basic MPS unit comes equipped with a 33-MHz 386. Want more power later? No problem. All you need to do is pull the 386 CPU board out of its proprietary slot and plug in an i486 (either 25 or 33 MHz) (see photo 2). Once you get the case off, the whole process takes about 30 seconds. And unlike the processor upgrade schemes that other manufacturers have opted for, ALR's requires no change of software or BIOS ROM upgrade. It's truly plug and play.

Riding the Micro Channel

Of course, other ALR systems upgrade in the same way. So what's the point of the MPS? Mainly, the Micro Channel. While the folks at IBM probably aren't quaking in their collective wingtips over ALR's Micro Channel entry, ALR has frosted the competitive cake with lots of sweet goodies, especially for the steely-eyed bean counters of the bottom line. Stripped MPS systems start at lowball prices—$1995 with no hard disk drive or graphics. And there's a well-chosen selection of upgrade options. For example, a 33-MHz 386-based MPS with a 16K-byte static RAM cache, an 80-megabyte hard disk drive, a Super VGA card, and a 14-inch color monitor costs about $4500. That's nearly half the price of a comparably equipped IBM PS/2.

ALR's entry is a compact 6 by 15 by 17 inches, weighing in at about 35 pounds. The motherboard in the preproduction MPS that I looked at still had hand-wired patches, but careful layout and construction were evident. Packing all this circuitry into a small case isn't a trivial undertaking, and it requires surface-mount fabrication techniques. ALR has used the Intel Micro Channel chip set and has ended up with considerably more expansion space than you find in the PS/2s. The MPS has a total of eight expansion slots (versus three in a comparable PS/2). Two of these are proprietary ALR slots, but there are four 16-bit and two 32-bit Micro Channel slots.

The World Gets Smaller

ALR has also opted for a semimodular case layout. As with a true PS/2, you pop out a few plastic buttons, and the drive bays lift off. But you still need to fiddle with cable connectors. And speaking of drives, ALR has also decided to emulate the PS/2 approach of eschewing 5¼-inch drives. You have a choice: Take 3½-inch drives or leave them. Period. But there's lots of room for them: space for four half-height units on the front panel, and room for two 3½-inch hard disk drives (mounted vertically) inside the case.

COMPANY INFORMATION

Advanced Logic Research, Inc.
9401 Jeronimo
Irvine, CA 92718
(800) 444-4257
(415) 581-6770
Inquiry 1081.

Despite all the circuitry crammed onto the MPS's motherboard (including an Intelligent Drive Electronics hard disk drive interface), there's plenty of room for expansion. A basic MPS comes with 1 MB of surface-mounted RAM on the motherboard. Add 256K-byte, 1-MB, or 4-MB single in-line memory modules to the four on-board sockets, and you can upgrade to 2, 5, or 17 MB in one fell swoop. Still not enough for you? Add an ALR 32-bit RAM card (that takes up to 22 MB), and you end up with a total system capacity of 49 MB.

Adding Processing Power

At press time, the cost of upgrading an MPS machine to a 486/25 was pegged at $1995; moving up to a 486/33 was a wallet-clearing $3195. But that's likely to change quickly; 486/25s are becoming more available, while 486/33s are likely to be hard to come by for some time. ALR also offers a trade-in rebate for processor modules. The rebate varies as the market changes, so check with the company for the latest details.

Those who are truly power (or is that status?) hungry can equip the MPS with a high-end TMS34010-based graphics

PRELIMINARY BYTE LOW-LEVEL BENCHMARK SCORES

We tested the ALR MPS with three different plug-in processor modules. Although its CPU results were on the low side of competing machines (and the video results were usually fast), note that the ALR was a prototype and the final production versions may (and probably will) differ.

	CPU	FPU	Disk I/O	Video
ALR MPS 386/33	4.83	14.35	1.61	11.77
ALR MPS 486/25	5.07	24.73	2.63	13.52
ALR MPS 486/33	6.82	32.98	2.68	17.13
ALR PowerVEISA 386/33	9.69	37.03	3.48	4.02
Compaq Deskpro 386/33	6.09	15.50	2.90	4.53
AST Premium 486/33	8.21	37.10	N/A	3.40
Cheetah Gold 33 (486/25)	6.52	21.49	9.49	5.57

Note: Benchmark results are indexed to show relative performance; higher numbers indicate better performance. For all indexes, an 8-MHz IBM PC AT running MS-DOS 3.30=1.

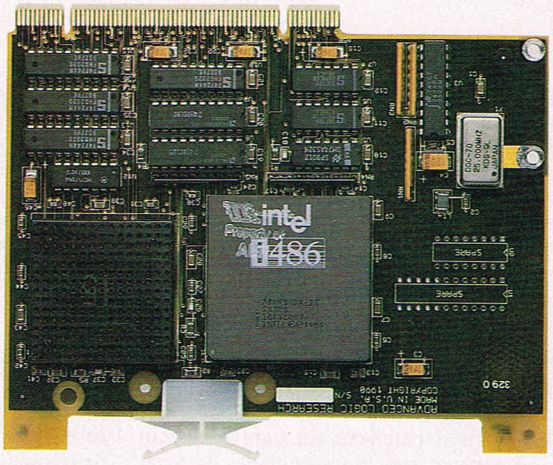


Photo 1: *The ALR MPS is highly modular, although not to the extent of the IBM PS/2 series, with which it directly competes. The drive bays detach with three pop-up plastic buttons, giving you easy access to the motherboard.*

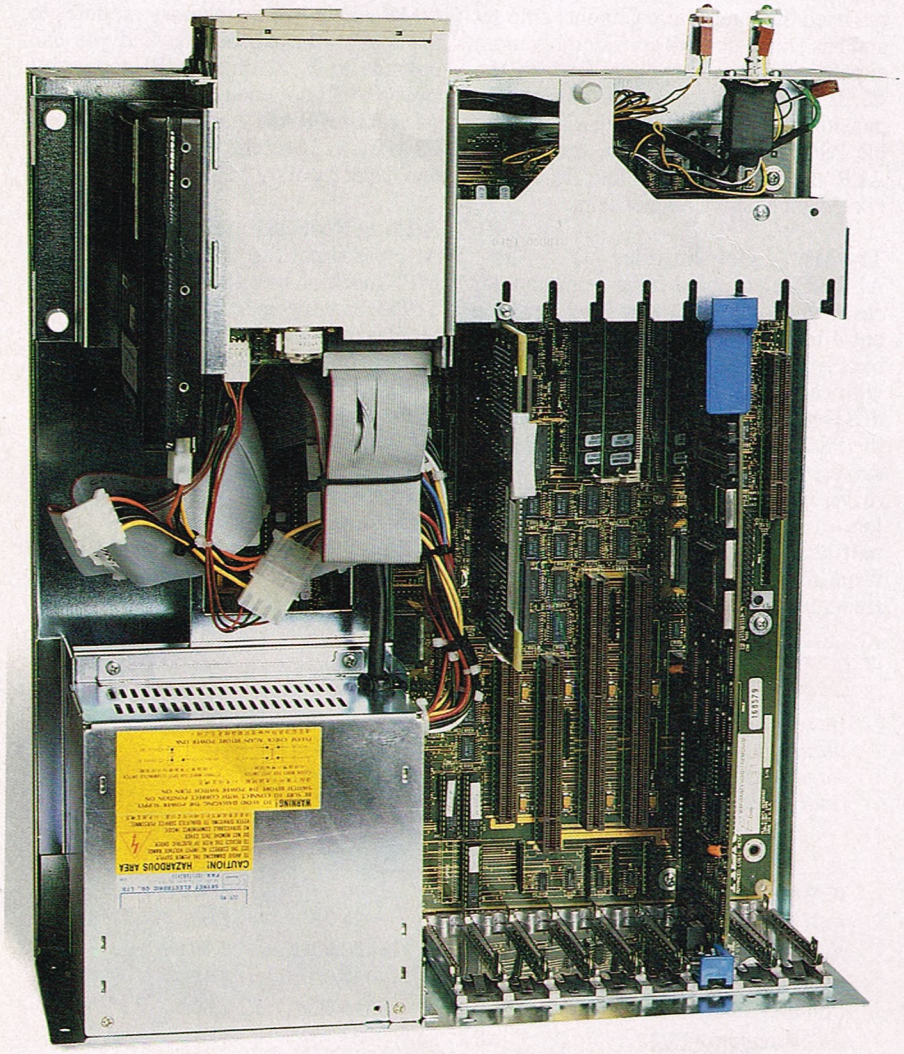


Photo 2: *You can upgrade ALR's CPU module (the 486/25 with a Weitek socket is shown here) in about 5 minutes. You don't need to upgrade the software or firmware.*

processor that emulates the 8514/A ($3300 with a 15-inch monitor; $5300 with a 21-inch monitor). And if the MPS is going to see duty as a network file server, there's a 330-MB hard disk drive that will add $2100 to the system price.

Mass Transportation

EISA? Industry Standard Architecture (formerly the AT bus)? Micro Channel architecture? Sometimes I feel like a confused commuter trying to decide which bus to take. An ALR spokesperson told me that ISA is essentially dead. That's an understandable statement on the company's part, because it wants to sell lots of EISA and Micro Channel machines. But ISA-based systems are far from obsolete, especially since the high-bandwidth, multiprocessing promises of both EISA and Micro Channel remain largely a dream. Many more add-in boards are available for the Micro Channel than for the EISA bus, but most are simple repackages of ISA products that offer little (or, more often, nothing) in the way of increased performance.

That situation will change, of course; and ALR is in a particularly good position to be a strong contender as the PC market eases leisurely toward high-power processors and high-bandwidth buses—complementary technologies that are just plain made for each other. The ability to upgrade your PC's processor in the future remains an intriguing one. (There will be an i586 one of these days.)

If you're considering going for a bus upgrade, the choice between EISA and Micro Channel is a somewhat thornier issue. Except for ever-true, ever-blue IBM users, Micro Channel–bus PCs haven't taken off since their introduction some 2½ years ago. Other non-IBM Micro Channel machines, such as those made by NCR, Reply, Tandy, and Wang, have largely been rolled out so that the companies can tout their "complete lines" to Big Corporate Buyers. I have a hunch that the ALR MPS is very much the same.

The MPS is well designed and well built, and it shows a high degree of engineering expertise and sophistication. But for the time being, its user base is likely to be confined to large companies who specify Micro Channel yet are looking for a lower-priced (and upgradable) alternative. While EISA and Micro Channel slug it out, ALR can profitably work both sides of the street. ■

Stan Miastkowski is the BYTE senior editor for new products. He can be reached on BIX as "stanm."

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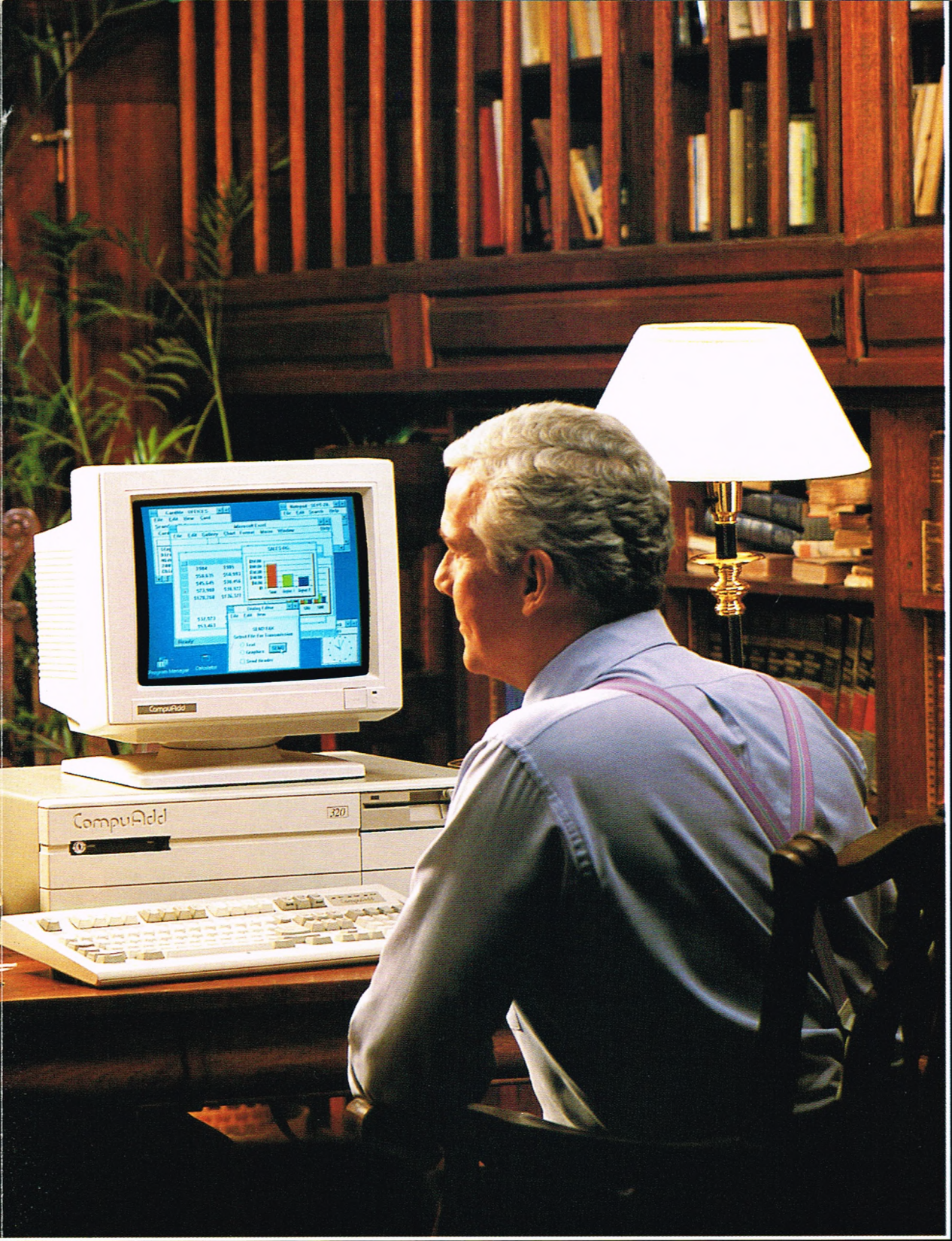
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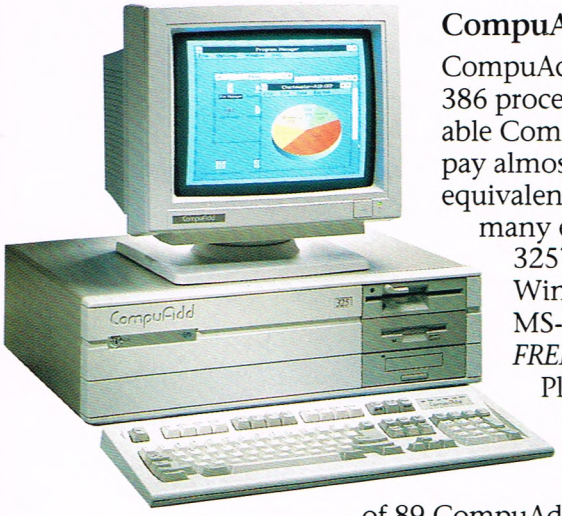
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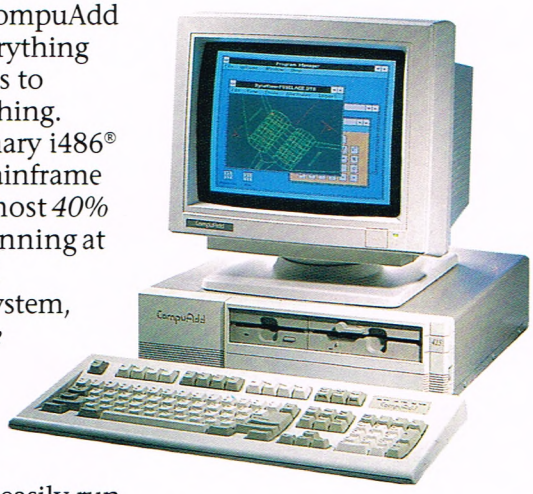
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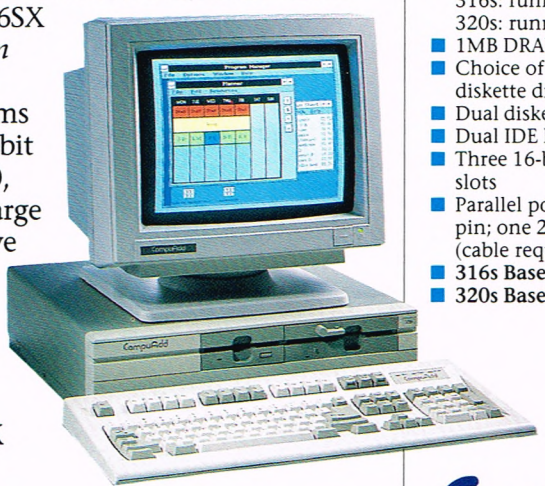
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Fast New Systems from NeXT

The new NeXT systems sport lower price tags, more speed, and a long-sought floppy disk drive

■

Nick Baran and
Owen Linderholm

In addition to considerable fanfare and praise, the original NeXT Computer received a fair share of criticism. It had been faulted for its lack of color options, high price, a perceived lack of performance, and—most often—its lack of a floppy disk drive. With the new NeXT systems that were introduced in September, NeXT has built on its past achievements and addressed the majority of these weaknesses.

NeXT now has a product line that features the new 68040 microprocessor running at 25 MHz, an MS-DOS-compatible 2.88-megabyte floppy disk drive, a new "slim-case" desktop model that retails for the relatively low price of $4995, and color options due out early next year.

According to NeXT's numbers, the 68040 has a performance rating of approximately 15 million instructions per second and 2.8 million floating-point operations per second (MFLOPS), about three times faster than the 68030 used in the original NeXT Computer. The 68040 also includes memory management and floating-point coprocessors on the main chip.

When the NeXT Computer was introduced in 1988, one of its primary features was an erasable 256-MB optical disk drive, which Steve Jobs touted as the floppy disk drive of the nineties, allowing users to "take their whole world in their backpacks." But the optical drive has proved to be too slow for use as a main storage device, and the cartridges are too expensive for use as a data-exchange medium: No one wants to send a file on a $50 storage medium. In addition, the price of the optical cartridges jacks up the price of third-party software. Nevertheless, the optical drive is excellent as a backup device and will be offered as an option for that purpose.

The floppy disk drive of the nineties is now the good old 3½-inch drive, but with an increased capacity of 2.88 MB and the capability to read and write files in 1.44-MB and 720K-byte MS-DOS formats. This floppy disk drive is now standard equipment on all NeXT machines and will be the primary medium for the distribution of software and data. The new NextStep operating-system software automatically mounts the floppy disk and displays its files in the system's Directory Browser. In addition, the software supports CD-ROM drives (see the text box "A New Version of NextStep" on page 167).

While the new 2.88-MB drive cannot read and write Macintosh-formatted files directly, the high-density floppy disk drive (SuperDrive) available on Macintoshes can convert to MS-DOS format; thus, Macintosh file compatibility should not be a big problem.

NeXT's system boards now include a twisted-pair 10-Base-T Ethernet port, as well as the thin Ethernet port that is on the current system board. Another change is the use of the 50-pin SCSI-2 standard rather than the older 25-pin SCSI standard. SCSI-2 offers greater reliability and faster transfer rates than does standard SCSI. SCSI-2 is backward compatible so that existing SCSI devices can be attached using a cable adapter. The new system boards also support parity memory checking, a feature that has been requested by scientific and engineering users.

It should be noted that the new system board still uses

Photo 1:
Unlike the original NeXT Computer, the new Nextstation Color features a slim-case, or "pizza-box," system unit. Inside is a powerful 68040 processor and 12 MB of RAM.



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the Motorola 56001 digital signal processor, despite speculation that the new machine would have the 96002 DSP, a successor to the 56001 that includes floating-point capability. NeXT says that the 96002 isn't currently fully backward compatible with software for the 56001. However, NeXT has added a single in-line memory module socket for up to 192K bytes of memory addressable by the DSP.

The Nextstation Pizza Box

The new Nextstation is clearly NeXT's answer to the SPARCstation. Made from magnesium with a cosmetic plastic shroud, the slim-case, or "pizza-box," system unit is about 15 inches square and 2½ inches thick, and it sits under the system's display. The system board is slightly larger than the original NeXT system board; the two are not interchangeable. The board includes two serial ports, a display port, the SCSI-2 port, and both thin and 10Base-T Ethernet ports. The Nextstation is cooled by a virtually silent "whisper fan" that passes air over heat-dissipating fins built into the bottom of the case. These lie directly under the power supply—a major heat source. The power supply is a 120-watt unit that uses a new technology called "parallel resonance switching," which allows a much smaller form factor than conventional power supplies.

THE FACTS

Nextstation
with 8 MB of RAM, 105-MB hard disk drive, 2.88-MB floppy disk drive, and 17-inch monochrome display, $4995

Nextcube
with 8 MB of RAM, 105-MB hard disk drive, 2.88-MB floppy disk drive, and 17-inch monochrome display, $7995

Nextstation Color
with 12 MB of RAM, 105-MB hard disk drive, 2.88-MB floppy disk drive, and 16-inch color display, $7995

Nextdimension
with 8 MB of RAM, $3995

NeXT, Inc.
900 Chesapeake Dr.
Redwood City, CA 94063
(415) 366-0900
Inquiry 1066.

The Nextstation is a welcome addition to the NeXT product line.

The Nextstation comes standard with 8 MB of memory (expandable to 32 MB), a 105-MB hard disk drive, and the 2.88-MB floppy disk drive. With the 17-inch black-and-white MegaPixel display, this system costs $4995. A reduced version of the operating system is shipped installed on the 105-MB hard disk drive and takes up about 75 MB on the disk, including 16 MB of swap space required for virtual memory mapping by the operating system. Unless connected to a network file server, a system with the 105-MB drive will require an additional hard disk drive for storing much third-party software and data. An internal 340-MB hard disk drive is available as an option instead of the 105-MB drive, in which case the system costs $6995, a rather hefty price increase for an added 235 MB of storage.

The Nextstation is a welcome addition to the NeXT product line. It is ideal for end users who don't need the storage or expansion capabilities of the NeXT Computer. The Nextstation was supposed to begin shipping in October.

A New Cube

The other new NeXT system is the Nextcube, the familiar cube but with a floppy disk drive instead of an optical drive, and space for one half-height and one full-height storage device (either two hard disk drives or a hard disk drive and a CD-ROM or optical drive). The 105-MB and 340-MB drives are half-height devices, while the 660-MB and 1.4-gigabyte units are full-height devices.

The Nextcube system board has the same features as the Nextstation system board, including parity memory and the SCSI-2 and 10Base-T ports, but memory can be expanded on-board to 64 MB. An 8-MB system with the 2.88-MB floppy disk drive, the 105-MB hard disk drive, and the 17-inch monochrome display costs $7995. The 340-MB drive option boosts the price to $9995. The Nextcube was scheduled to ship in September.

Color Options

NeXT will offer two "color solutions": a low-end system for business applications, presentation graphics, and two-dimensional CAD, and a high-end system for scientific imaging, professional graphics production, 3-D modeling, and so forth.

At the low end will be a color version of the Nextstation with 16-bit-per-pixel color, allowing 4096 colors on-screen simultaneously (12 bits for color and a 4-bit "alpha channel" for specifying transparency). At the high end will be an add-in board with 32-bit color, its own graphics processor, and a processor for compressing and decompressing graphics images, allowing 16 million colors on-screen simultaneously (24 bits for color and an 8-bit alpha channel for specifying transparency).

The Nextstation Color

The Nextstation Color (see photo 1) is the same slim-case machine as the Nextstation, except that it supports 16-bit color. It comes standard with 12 MB of RAM and 2 MB of video memory. NeXT increased the memory bandwidth somewhat on this model to improve video performance. The Nextstation Color is designed for use with NeXT's new color MegaPixel display, which is a 16-inch Sony Trinitron display with 1120- by 832-pixel resolution (the same resolution as the black-and-white display). The 12-MB system with the color display, a 105-MB hard disk drive, and the 2.88-MB floppy disk drive will cost $7995. As with the Nextstation, an additional hard disk drive will be necessary unless the system has access to a network file server.

The Nextstation Color does not require NeXT's color MegaPixel display. By purchasing NeXT's ColorConnect adapter, you can connect any size color display that is capable of showing images in the correct resolution. The ColorConnect adapter provides the sound and speaker functions that are normally built into the MegaPixel display. Pricing for the ColorConnect adapter was not available at the time of this writing, but a Nextstation Color without a monitor will cost $4995. There is no upgrade path between the black-and-white Nextstation machine and the Nextstation Color. Unfortunately, the Nextstation Color will not ship until early 1991.

Upgrading Existing Cubes

As NeXT announced several months ago, current NeXT users will be able to obtain a 68040 upgrade for their NeXT Computers for $1495. This will involve swapping the 68030 system board for the new 68040 system board. NeXT has also

A New Version of NeXTStep

In conjunction with the new hardware in its product line, NeXT is providing a major upgrade to its operating-system software. NextStep 2.0 includes support for the new hardware components, such as the 2.88-megabyte floppy disk drive, CD-ROM drive, color display, and 10Base-T Ethernet, as well as a host of improvements to the interface and development environment.

To accommodate the comparatively small 105-MB hard disk drive that is standard on all the Nextstation models, NeXT has split NextStep into two versions: release 2.0 and release 2.0 Extended.

The extended version includes all the current developer's tools, such as the Application Kit and the Interface Builder, as well as some new enhancements aimed at application developers. However, neither version will include Mathematica, Common Lisp, or the Sybase database manager. Release 2.0, a reduced version of NextStep, does not include the Interface Builder or the Application Kit, and it has a reduced version of Webster's Ninth New Collegiate Dictionary without the illustrations or the full text index. The reduced version also has fewer demonstration programs and does not include the Shakespeare plays or The Oxford Dictionary of Quotations.

NeXT may find that most customers want the extended version and opt for a larger hard disk than the 105-MB unit. However, for networked users who have access to a file server, the reduced version simply reduces the local storage requirements. In any case, release 2.0 and release 2.0 Extended are functionally equivalent so that users will be able to move to the extended version simply by installing a larger disk capacity and copying the missing files.

An Improved Interface

NextStep 2.0 addresses several major weaknesses of release 1.0. Of particular importance, the Workspace is now multithreaded so that file operations such as copying and moving can be done in the background, allowing the user to continue working on other tasks.

The printing interface has also been redesigned to operate at a lower priority so that the screen doesn't lock during print operations. The tradeoff is slower printing performance in exchange for a live screen. In addition, the printer interface now includes an option for sending fax documents. If you have a fax modem, you can fax anything that can be printed by simply clicking on the new Fax option in the Print menu.

The Workspace has received some cosmetic changes in release 2.0. The Directory Browser has been redesigned and now includes a "shelf" at the top of the browser window where users can place frequently used files and folders. The Browser also includes a new window that shows the "icon history," or status, of applications and folders that are in use. Clicking on an icon in the window displays the path of the file or the folder graphically in the Directory Browser. The icon history window replaces the icon well in the current Directory Browser.

The Mail application has been improved in release 2.0. Mail now includes an archive facility for storing mail messages. A return receipt function has been added, as well as support for sending mail to recipients with non-NeXT systems that require a standard font, wrapped lines, and carriage returns for 80-column text. Release 2.0 includes spelling checking and rulers built into the Text Object, so that these features are now supported in Mail.

The development environment has been improved in release 2.0 and includes support for color. A new object called the Color Picker works similarly to the font panel and allows you to select and mix colors. The window server supports frame buffers of different size and depth to accommodate the use of third-party color monitors. NeXT plans to support the RenderMan scene-description language for three-dimensional rendering in a future release of NextStep, due early next year.

Release 2.0 supports loadable device drivers, allowing developers to create custom applications for peripherals like video and sound equipment and special-purpose display and output devices. All text objects now automatically include a spelling checker and rulers.

Other new features include an improved MIDI driver that supports arbitrary sampling rates and PostScript composite fonts, a feature of Adobe's PostScript level 2. Composite fonts allow support for kanji and other alphabets.

Availability and Upgrades

NeXT was optimistically hoping to have release 2.0 ready in September. At press time it was still not finished, but NeXT was confident it would be ready in time. In any event, the new machines won't run without it, so completion is a top priority.

The system software will be shipped preinstalled on hard disks, relieving the user of the time-consuming Build Disk operation. Current users of release 1.0 will be able to upgrade to 2.0 on an optical drive for $195, which includes new manuals.

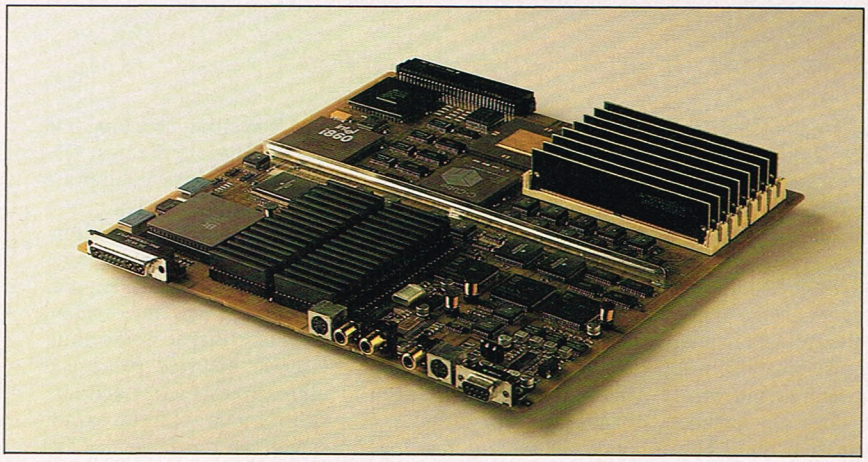


Photo 2:
The Nextdimension board provides the Nextcube with high-performance color graphics. On the board is an Intel i860 RISC processor, 4 MB of video RAM, and room for up to 32 MB of memory.

contracted with a third-party supplier to provide an external 2.88-MB floppy disk drive for current NeXT Computer owners. Pricing and availability of the floppy disk drive have not been announced as of this writing, but, according to sources at NeXT, it will be available within the next couple of months.

To go along with all this new hardware, NeXT is cutting the price of its high-resolution 400-dot-per-inch laser printer almost in half. Originally selling for a retail price of $3495, the printer is now priced at $1795, representing a substantial reduction in the cost of a complete NeXT system.

Doing Color Right

NeXT president Steve Jobs promised from the beginning that NeXT would eventually support color, but not until it's "done right." And indeed, NeXT has done color right. Using the PostScript imaging model, color on the NeXT is device independent; in other words, applications written using color PostScript specifications can be displayed on any output device that supports PostScript, whether it's a screen or a printer supporting black and white, gray scale, or various resolutions of color.

In addition, PostScript offers excellent performance in color. When you compare Color QuickDraw on the Mac IIfx and color PostScript on a 68030-based NeXT Computer, you find that screen refresh and movement of color images are much faster on the NeXT. And, unlike with Apple's QuickDraw and TrueType image and font models, there is no need for conversion routines to display PostScript images on PostScript devices.

High-End Color: The Nextdimension

NeXT's high-end color solution is an add-in board called the Nextdimension (see photo 2). The board plugs into one of the three NextBus slots in the NeXT Computer, and it features Intel's i860 microprocessor, which is rated at 80 MFLOPS and offers high-speed graphics processing. The board has 4 MB of video memory, plus up to 32 MB of RAM for increasing the display's windowing capacity (i.e., the number of windows that can be displayed on the screen simultaneously).

In addition, the board includes the C-Cube Microsystems CL550 image-compression processor, which can compress video and bit-mapped images in ratios of up to 30 to 1 using the Joint Photographic Experts Group image-compression algorithm. The board supports NTSC and SVideo (SuperVHS and High 8mm) images for both input and output, as well as RGB color. One 640- by 480-pixel window can display live NTSC or SVideo images. In conjunction with the C-Cube image-compression processor, the live window can display 30 frames per second for true real-time motion video.

Like the Nextstation Color, the Nextdimension supports the new color MegaPixel display and, using the ColorConnect adapter, third-party color displays. The color display can run simultaneously with the black-and-white MegaPixel display, allowing a contiguous work space consisting of the two screens. Images or text can be dragged from one screen to the other as if the two screens made up a single display. For intense graphics users, up to three Nextdimension boards can be installed in one NeXT Computer, each with a separate monitor.

The Nextdimension will be priced very competitively at $3995, which includes 8 MB of RAM. A complete color system (a Nextcube with the color MegaPixel display and the Nextdimension board) will cost about $15,000, making the system very competitive with similar systems from Sun and Apple. The Nextdimension should ship early in 1991.

High-Speed Color at a Low Cost

These new systems and the updated NextStep software give NeXT a very powerful, well-rounded, and extremely competitive product line. The Nextstation system may now be the workstation price/performance leader. A Nextstation with a laser printer makes a powerful desktop publishing setup.

But where NeXT has really taken a lead is in the color arena. NeXT's decision to go with Display PostScript is paying off in a big way. The system has one consistent model for both displaying and printing. And, despite rumors to the contrary, its performance is outstanding.

The new NeXT systems are going to be extremely competitive with high-end desktop personal computers, especially high-end Macintoshes. The products will also compete well in the low-end workstation market. And since educational establishments and developers continue to get a 30 percent discount, these systems will be even more competitive in universities.

Perhaps the biggest task left to NeXT is to persuade software vendors to write programs for NeXT systems. But that is changing, as Lotus and Ashton-Tate have announced new spreadsheet programs in conjunction with the new systems' introduction in September. Lotus's spreadsheet in particular shows why the NeXT systems are so important. The program is completely innovative in every way and is pointing the way ahead for the future of software and hardware—just like the NeXT machines themselves are. ■

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Massive Storage for Multiple Platforms

The BYTE Lab rates high-capacity hard disk drives for DOS, Macintosh, NetWare, and Unix applications

Steve Apiki, Stan Wszola, Rick Grehan, and Tom Yager

Devotees of Macintoshes, NetWare 386 file servers, single-user DOS systems, and Unix machines have something in common: Sooner or later, they all see a disk error message that means "insufficient space."

This month, the BYTE Lab looks at 15 high-speed, high-capacity hard disk drives that offer relief from overcrowded data. Along with new levels of performance, the SCSI connector that these drives share also promises easier upgrades when a drive no longer seems as roomy as it did in the showroom.

The SCSI bus protocol defines how peripherals talk to the host and to each other. SCSI is fast—4 megabytes per second at the top end—and that is driving its acceptance across the four major operating systems. But SCSI also lets you chain drives together, so today's investment in a 300-MB drive can be the foundation of a larger system years down the road.

The BYTE Lab compared SCSI drives with capacities of between 300 and 420 MB in configurations ranging from barebones OEM systems to full plug-and-play packages. We tested each in single disk drive configurations under MS-DOS, NetWare 386, Unix, and the Mac OS (not all drives were compatible with all operating systems). The text box "How to Measure Drives Across Four Operating Systems" on page 176 explains our benchmarks.

You're not likely to find the OEM units from Fujitsu, Western Digital, and Micropolis at your corner computer store, but larger mail-order houses might stock them. Their performance, however, provides a good point of comparison for retail products built around them. Western Digital purchases its WD380 SC drives from IBM, so the WD380 SC should give a reasonable indication of IBM's SCSI system performance.

Interface Heritage

SCSI controllers trace their lineage to Shugart Technology's ST506 interface, introduced by that company in 1980 to support its 5-MB hard disk drive. ESDI, which is more or less a direct descendant of ST506, appeared in 1983 and offered double the throughput rate of its ancestor. More recently, the Intelligent Drive Electronics (IDE) interface has grown in popularity, because it requires less circuitry on the host, allowing engineers to design smaller-footprint systems.

SCSI drives handle communications between computer and disk drive at a higher level. For example, when applications talk to a SCSI drive, they are unaware of the drive's configuration details, such as the number of cylinders, heads, and sectors. The drive appears as a collection of sequentially numbered blocks. Thus, SCSI moves a substantial amount of intelligence onto the drive. Consequently, SCSI is far more flexible than the other interfaces. (See the text box "The Fuzzy Side of SCSI" on page 186.)

This doesn't mean that traditional measures of performance—seek and access times—are obsolete. The drive still needs to physically seek the requested tracks and wait for the requested sector to come around. However, SCSI makes some traditional benchmarks obsolete. Timing track-to-track seeks and attempting to factor in seek latency is no longer possible from an application perspective.

Since the drive's geometry can be hidden from the host computer, manufacturers can optimize controller electronics for the drive itself without having to pass any resulting customizations on to the host. This lets a single host adapter talk to a wide variety of drive types. Additionally, drive manufacturers can place cache memory directly on the drive controller; any system RAM that you might have been using for a disk cache can go back to running programs.

Points for SCSI

SCSI sports a few other features favored by systems integrators and others who are faced with rising disk space and performance demands. First, SCSI easily handles large-capacity drives. As an example, the SCSI extended read command accepts a 32-bit block number. Given a block size of 512 bytes (the standard with the drives we tested), a single disk drive could hold 2 terabytes of data.

Second, multiple drives can be daisy chained on the SCSI bus. This is handy for network administrators, who can easily add drives as network users demand more storage space. One SCSI bus can accommodate eight devices: one host computer and seven peripherals. Consequently, the maximum number of drives that you can hang off a single SCSI port typically is seven. However, each device on a SCSI bus can incorporate eight logical units, which in turn can incorporate 256 logical subunits.

Third, SCSI supports multiuser and multitasking operating systems. Devices on a SCSI bus are either initiators (i.e., the host computer) or targets (i.e., the disk drives). Once the host computer passes a request to the disk drive, the host can disconnect from the drive rather than wait for the request's completion. The host then can perform other processing while the drive services the request.



PHOTOGRAPHY: PAUL AVIS © 1990

SCSI DRIVE FEATURES

In addition to performance, other features that can help determine the right high-capacity SCSI drive for you include formatted capacities, failure rates, and warranties. Compare these vendor-supplied average seek times with results obtained in the BYTE Lab, shown in figure 1 (●=yes; ○=no).

Model	Prevail 325	SLAN 310	M226 ISA	hammer300	ZPF 300	Micro/Stack	1684
Vendor	CMS Enhancements	Core International	Fujitsu America	FWB	La Cie	MicroNet Technology, Inc.	Micropolis Corp.
Drive manufacturer	CMS	Core	Fujitsu	Seagate Wren	Seagate Wren	Seagate Wren	Micropolis
Formatted capacity (MB)	340	330	415	300	332	423	340
Price (specific configuration)							
DOS	$4195	$3890	*	$3395	*	$4290	$2410
Mac	*	$3890	*	$3495	$1699	$3795	$2410
Novell NetWare	$4195	$3890	*	$3595	*	$4389	$2410
Bare drive	*	$3295	$2950	$2995	*	*	$1995
Host adapter manufacturer	Adaptec	Western Digital	*	Always	*	MicroNet	Adaptec
Model	1540	WD7000		IN2000		HA-01	AHA-1542B
Dimensions (inches)	5×5¾×8	14½×5⅝×4¾	3⅜×5⅞×8	2½×9½×9¾	9½×9½×4½	3⅛×10×3⅜	1⅜×5¾×8
Weight (lbs.)	7	9.89	7.7	7.6	12.2	8.75	5
Power consumption (watts)	33	16	30	16	16	30	15
Mean time between failures (hours)	150,000	150,000	200,000	100,000	100,000	100,000	150,000
Warranty (years)	2	5	5	1	2	1	1
Internal or external installation	Int./ext.	Int./ext.	Int./ext.	Int./ext.	Int./ext.	Ext.	Int.
SCSI-1 or SCSI-2 support	SCSI-2	SCSI-1	SCSI-2	SCSI-1	SCSI-1	SCSI-1	SCSI-2
Sync. data transfer rate (MB/sec.)	N/A	4	4.8	4	4.7	N/A	4
Async. data transfer rate (MB/sec.)	1.6	2	2	2.5	N/A	1.5	1.6
Burst or sustained?	Sustained	Sustained	Burst	Sustained	Sustained	Sustained	Sustained
Average seek time (milliseconds)	16.5	18	14.5	14	14	16	14
Average latency (milliseconds)	7.5	8.33	8.3	8.33	8.33	8.3	8.33
Recoverable error rates (bits read)	1×10^{11}	1×10^{14}	1×10^{11}	1×10^{10}	1×10^{10}	1×10^{14}	1×10^{13}
On-board cache (K bytes)	*	*	*	*	*	*	*
Look-ahead buffer (K bytes)	64	64	64	48	48	64	64
Dedicated or embedded servo	Embedded	Embedded	Dedicated	Dedicated	Dedicated	Dedicated	Dedicated
Drive-select configuration	Switches	Switches	Jumpers	Switches	Switches	Switches	Jumpers
Automatic head parking	●	●	●	●	●	●	●
NetWare-ready	●	●	○	○	*	●	○

N/A = Information not available.
* = Not applicable.

The two reconnect at a later time to complete the transaction.

Optional synchronous data transfers can also improve throughput. Ordinarily, SCSI devices perform asynchronous data transfers that require request/acknowledge handshakes for each byte transferred. Synchronous transfer lets a sender transmit bursts of data without waiting for acknowledgment signals between each byte. An agreed-upon number of acknowledge signals are left outstanding, and the receiver catches up with the sender at the end of the transfer.

Finally, there is the promise of the backward-compatible SCSI-2, which a few of these drives support partially (see the features table). SCSI-2 provides for optional 16- and 32-bit data transfers. In its 32-bit incarnation, SCSI-2 can howl along at up to 40 MB per second. (For a complete discussion of SCSI protocols, see "The SCSI Bus," Parts 1 and 2, in the February and March BYTE.)

SCSI Enters the DOS World

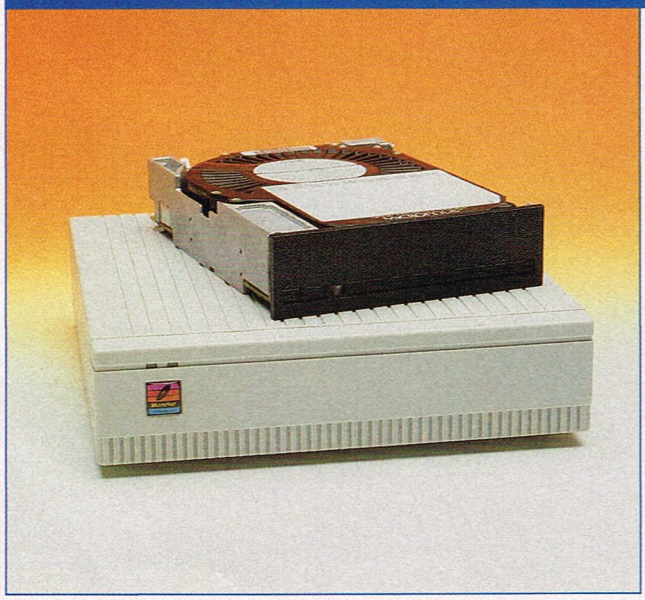


Photo 1: *MicroNet's Micro/Stack and the Micropolis 1684 led the field in performance under DOS.*

SCSI DRIVE FEATURES

HCS300E	Diskovery 325	ED 330 SC	Cobra 330e	X/Stor xsh1-330S1	MacinStor MAC325-S1	DataFrame	WD380 SC
N/Hance Systems, Inc.	Optima Technology	Priam Systems	Rodime Systems, Inc.	Storage Dimensions	Storage Dimensions	SuperMac Technology	Western Digital
Seagate Wren	Optima Technology (OEM)	Atasi	Micropolis or Maxtor	Seagate Wren	Seagate Wren	Seagate or Micropolis	IBM
299	321	330	330	330	325	320	320
$3995	$4390	$3122	*	*	*	*	*
*	$4190	*	$3999	*	$3499	$3399	*
$4195	$4190	$3714	*	*	*	*	*
*	$3995	$2714	*	$4160	*	$3299	$3800
Future Domain TMC-860	Adaptec AHA-1542B	Future Domain TMC-870	*	Adaptec AHA-1542B	*	*	*
3¼×5¾×8	2⅝×11⅞×10⅛	7 7/10×4⅘×13 7/10	7×14⅜×4 1/10	1⅜×5¾×8	14⅜×7¾×5 7/10	5×8×9½	1⅜×5¾×4
7.2	9	13	13	4.2	18	24	2.2
26	20	35	30	16	16	37	11.9
100,000	100,000	50,000	50,000	100,000	100,000	100,000	150,000
1	1 or 3	1	2	2	2	1	1
Int./ext.	Ext.	Ext.	Int./ext.	Int./ext.	Int./ext.	Int./ext.	Int.
SCSI-1	SCSI-2	SCSI-1	SCSI-1	SCSI-1	SCSI-1	SCSI-1	SCSI-2
N/A	4.8	4	N/A	5	4.75	2	4
14.3	2	N/A	14.3	2	N/A	N/A	4
Burst	Burst	Burst	Sustained	Burst	Burst	Sustained	Burst
16.5	14	18	14.5	14	14	17	12.5
8.33	8.33	8.3	8.3	8.33	8.3	8.33	6.95
1×10^{14}	1×10^{14}	1×10^{19}	1×10^{10}	1×10^{9}	1×10^{9}	1×10^{21}	1×10^{10}
*	48	*	*	48	48	32	*
32	*	64	45	*	*	*	64
Dedicated	Dedicated	Dedicated	Dedicated	Dedicated	Dedicated	Dedicated	Dedicated
Switches/jumpers	Switches	Switches	Switches	Switches/jumpers	Switches/jumpers	Switch/software	Jumpers
●	●	●	●	●	●	●	●
○	○	●	*	○	*	*	○

Three hundred megabytes may seem like overkill for DOS, where the typical system is called upon to serve only one user, one task at a time. But with the growing popularity (and practicality, with faster machines) of large databases, scanned documents and other image files, and extensive programming environments, even DOS users occasionally find themselves hunting around for truly massive storage.

DOS's relatively simple, single-user, single-tasking nature makes the quickest drives really stand out. Under DOS, your requests for sequential sectors are likely to actually read sequential regions on the disk, whereas a multitasking operating system may have background processes that interfere with this sequential access.

Setting up each of the drives was straightforward. A BIOS ROM mounted on the host adapter scans the SCSI bus for active drives; no device drivers are necessary in single-drive DOS configurations. None of the drives had any operating or installation problems.

Each subsystem provides DOS services via the boot ROM mounted on the host adapter. At boot time, the option ROM installs itself, supplanting the built-in drive BIOS. The host-adapter ROM then processes BIOS requests and converts them into requests that are appropriate for the given drive.

To some extent, the performance of these drives depends on the host adapter. Except for the Fujitsu America, Micropolis, and Western Digital units, which were delivered in bare-drive configurations, we tested each drive with its own host adapter. The bare drives ran with an Adaptec AHA-1542B host adapter, a high-performance controller that should not impose any limits on drive performance.

Of course, the ultimate performance determinant is the drive itself. Several manufacturers use sophisticated techniques for improving both seek time and throughput. Seek time can be improved through the use of a dedicated servo architecture, where one face of one platter is dedicated to maintaining head-positioning information.

Some drives improve throughput using a technique known as *read-ahead buffering*, which speeds sequential disk-read access by bringing in more data than you requested. The disk can sometimes guess that you'll want to see the sectors that follow the one you asked for. Often, the drive controller will bring in the whole track. That's not as wasteful as it sounds. On a 1-to-1-interleave disk, it takes only a single revolution of the platter to read an entire track. On a freshly formatted disk (such as those used for these tests), sequential reads and writes almost certainly will fall in contiguous sectors.

A number of drives posted excellent DOS test results, but two stood out. The Micropolis 1684 combined exemplary

How to Measure Drives Across Four Operating Systems

Testing high-capacity hard disk drives on four diverse operating environments makes constructing relevant, accurate tests a unique challenge. Our performance evaluations focus on responsiveness at the file system level, because that's where users in each environment directly experience the relative speed or sluggishness of each drive. You can track these test results in figure 1.

The heart of our test suite is the file I/O benchmark, which consists of four separate tests: random and sequential writes, and random and sequential reads. Sequential tests record a drive's flat-out read and write throughput, while random tests provide a harsher but more realistic determination of application performance. Note that our random read and write test results are combined, using an average, to simplify our graphs.

The file I/O benchmark first creates a large file, allocating enough space on the drive for the entire file at its inception. Then the file I/O benchmark times a rewrite of the entire file in a sequential fashion. Each chunk of data is of random length (but a multiple of 512 bytes to keep the writes sector-aligned) to avoid favoring any drive geometry.

Next, the program conducts the random read and write tests to break up any cached sectors that the drive may have after completing the sequential write. Random reads and writes occur entirely within the large file, and we made no effort whatsoever to keep the file offsets or length requests sector-aligned. This method causes repeated seeks and might cause additional read-before-writes to occur on write requests, but we think it best reflects the way applications actually access data in files.

Finally, the file I/O test reads back the entire file sequentially. The tests cover basic writing and reading activities, but they do little to measure how drives respond when you impose the added burden of updating directories and allocation information. Our second file system test makes that measurement: It's the time it takes to copy a large directory structure. Under DOS and for NetWare clients, this means XCOPY; on the Macintosh, we accomplish the tree-copy test via an MPW (Macintosh Programmer's Workshop) script; and on Unix, we use `find` coupled with `cpio` to complete the task.

Our one low-level test measures seek time, a basic parameter that will affect drive speed in any application. A FlexStar 3000s dedicated test system measured seek times (see figure A).

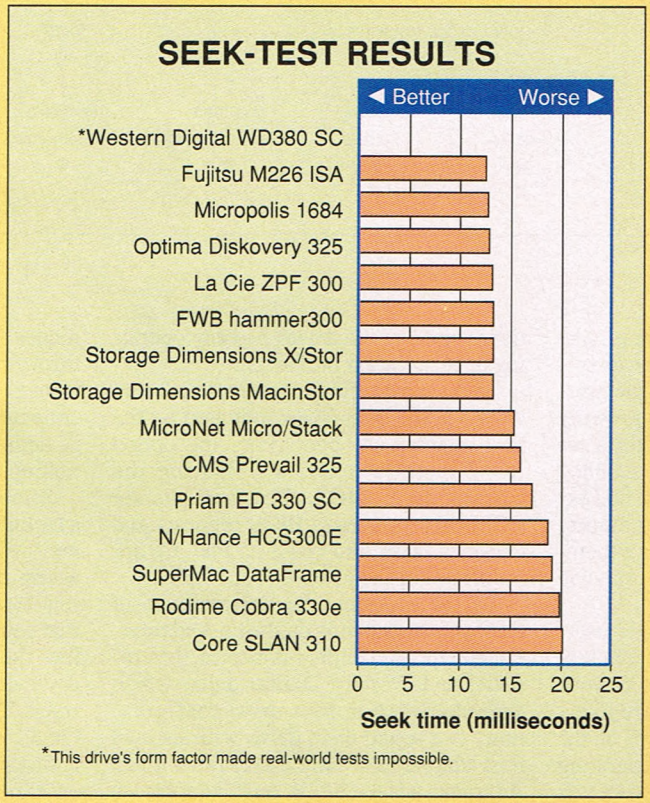


Figure A: *Raw seek times measured by the BYTE Lab compare roughly with vendor-specified average seek times, shown in the table. Shorter lines indicate better results.*

Unfortunately, we were unable to obtain meaningful results for the Western Digital WD380 SC. We used a canned seek-test routine, which issues a number of SCSI seeks. The Western Digital drive, because of its small form factor, must "rest" between seeks for better heat dissipation; this occurs only on seeks, not on reads or writes.

We ran DOS 4.01 and NetWare 386 tests on 33-MHz 386 systems from Club American and Arche Technologies. For drives shipped without a host adapter, we used an Adaptec AHA-1542B card. Each test setup used the drive under test as its sole hard disk drive.

To test the SCSI drives under Unix, we added the Adaptec controller to an Everex Step 33-MHz 386 system with 4 megabytes of memory. The system used an internal 150-MB hard disk drive, which we loaded with version 2.2 of Interactive Unix System V. We configured Unix to treat the Adaptec as a secondary controller. We built a 150-MB file system on the Unix partition of each SCSI drive.

Our Macintosh test setup included a Mac SE/30 that was equipped with 2 MB of memory and running System 6.05. We simply connected each drive in turn to the Mac's external SCSI port and formatted them using vendor-supplied software.

Our benchmarks are relevant only for comparison. In Unix, for example, our 4-MB system left little room for the all-important kernel buffers, and we made no effort to tune each system for maximum performance. With each operating system, your performance will probably be better with a fully tuned system. The important thing to consider when making comparisons is that each drive should be run on an identical system, as these were.

sequential write numbers and killer results on the tree-copy test, to earn first place overall. MicroNet's Micro/Stack posted the best sequential read time and performed very well on the tree-copy test (see figure 1 and figure A).

Micropolis claims that its proprietary cache feature enhances performance. The cache is especially sensitive to directory and file allocation table (FAT) use on the drive, and it attempts to keep these locations buffered as much as possible. Excellent numbers on the tree-copy test, which makes the most use of directory entries, confirms this claim. Short seek times helped performance, as well.

MicroNet's Micro/Stack drive did very well on the tree-copy test, despite a lackluster seek time. However, the outstanding read throughput more than made up the difference. The Micro/Stack included a bundled host/adapter/driver combination, which MicroNet optimized for use with the drive. MicroNet's solid performance can also be attributed to its low-level format optimizations, which remap the drive geometry to one that makes better use of available head/cylinder combinations.

Fujitsu, FWB, Optima, and Western Digital drives made up the middle of the group, all with respectable times. Fujitsu's M226 ISA and Western Digital's WD380 SC should provide a solid basis for an OEM system. To its credit, the Western Digital drive is much smaller and quieter than the Fujitsu drive. As in our other environments, the Optima and FWB drives paralleled each other in speed.

SCSI Slakes Unix's Thirst for Storage



Photo 2: *Unix system honors went to FWB's hammer300, Optima's Diskovery 325, and Storage Dimensions' X/Stor.*

With its massive appetite for storage and performance, Unix is a good match for SCSI. Its single-rooted file system structure lets you place new devices anywhere you want them. The multitasking nature of the operating system also maps well to SCSI's asynchronous nature.

Our file I/O tests showed off the strengths and weaknesses of Unix as related to the other test environments. The DOS and Macintosh numbers for sequential read and write, for example, seem positively astonishing compared to Unix. The only other multitasking environment we tested, NetWare 386, shows some similarity to Unix's numbers. On a single-tasking machine, it's acceptable to have the system "go away" for up to several seconds while disk I/O is being done. The amount of data that can be written before making the system responsive again is greater, because the user expects the system to freeze up briefly.

When you start multitasking, however, things get more complicated. Responsiveness becomes a priority; you don't want your keyboard to lock up while the disk is active. Under Unix, as with NetWare, more users (or processes) pound on the disk than under DOS, and the size of the atomic disk operation is much smaller. So, while a DOS system might be content to go blind for 5 seconds while it spews a huge block of data out to disk, Unix demands that a device driver finish its work in a few milliseconds.

Developers of Interactive Unix grafted device drivers and some specific changes onto standard System V Unix to improve performance. Interactive Unix's Fast File System (FFS) attempts to optimize sequential I/O by dynamically adjusting the amount of data read from disk in a single operation. It assigns as much I/O as possible to clusters of contiguous disk blocks. The more sequential your data access patterns, the more the file system adds to your I/O block size. As you return to random access, the file system quickly scales down, limiting the read-ahead.

The other half of Interactive Unix's optimization lies in the High Performance Disk Driver. This unified driver works from a table that lists the capabilities of supported disk controllers. The HPDD tries to squeeze maximum performance from each controller. In the case of the Adaptec AHA-1542B used in our tests, the HPDD takes advantage of the controller's *scatter-gather* capability. It optimizes disk access by collecting disjoint requests, sorting them in sector order, and getting them on or off the disk with a minimum number of seeks.

Scatter-gather also applies well to Unix's buffering scheme. An application rarely writes data directly to a disk. Instead, data resides in one of a number of kernel buffers. When the number of available buffers gets low, or when a periodic timer expires (whichever comes first), the "dirty" buffers are written to disk. Each buffer remains as long as possible until some other process needs to write to it. The driver tags each buffer with the disk ID and sector number from which it was loaded. If a read request comes in later for that same sector, the buffer supplies the data without requiring a read from the disk. Because each buffer is tagged with a sector number, buffers can readily be grouped and sorted. Interactive Unix enhanced this standard Unix mechanism by combining contiguous buffers into one to increase the amount of data that can be written in one operation.

Last on the list of technical considerations is the concept of *asynchronicity*. SCSI drives are intelligent, each one possessing its own built-in controller and, optionally, cache, and they can perform certain operations asynchronously. Most notably, seeking can take place on several drives simultaneously. The SCSI host adapter sends the seek commands to the drives and doesn't bother to wait for the drive to say, "I'm there." Instead, it

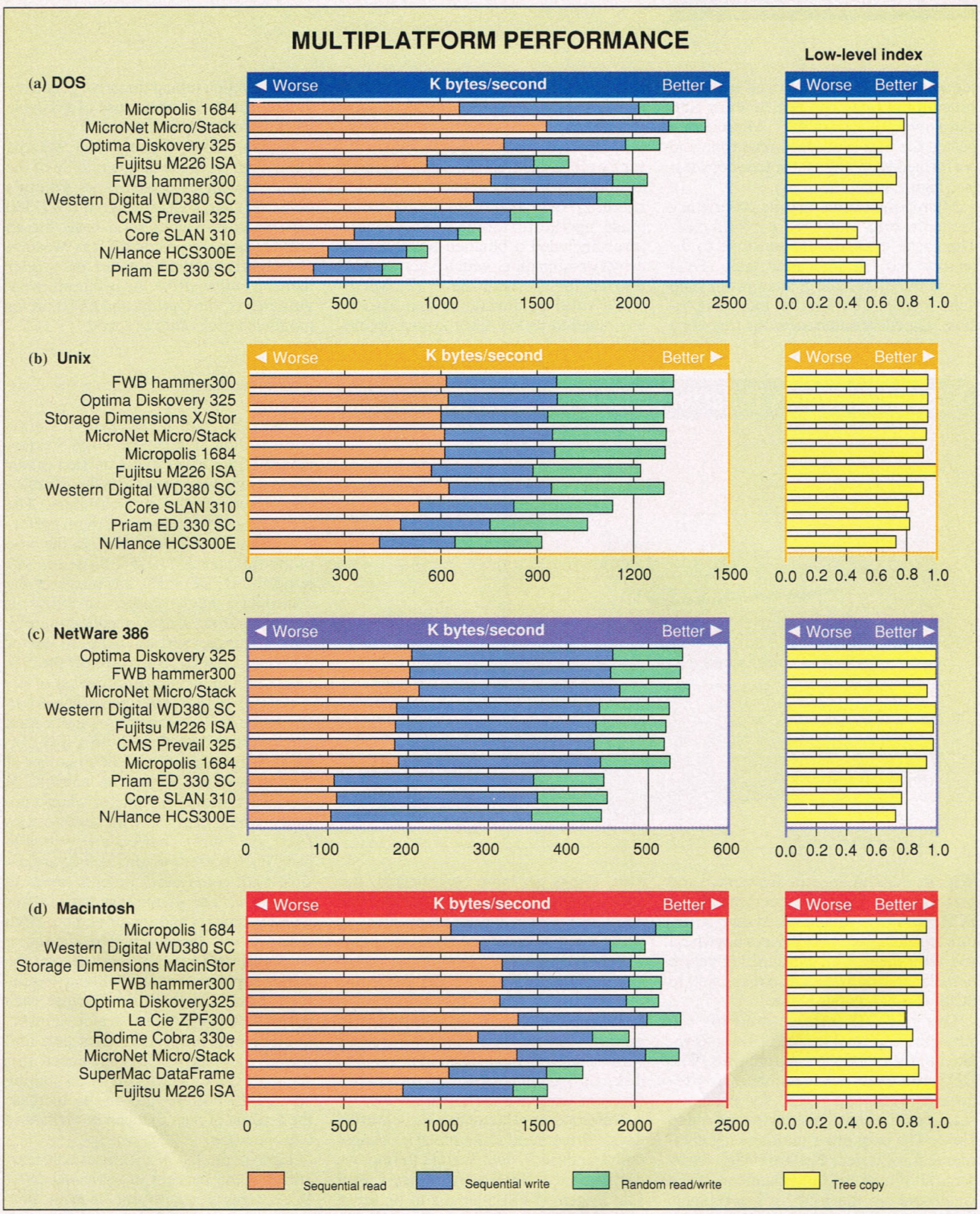
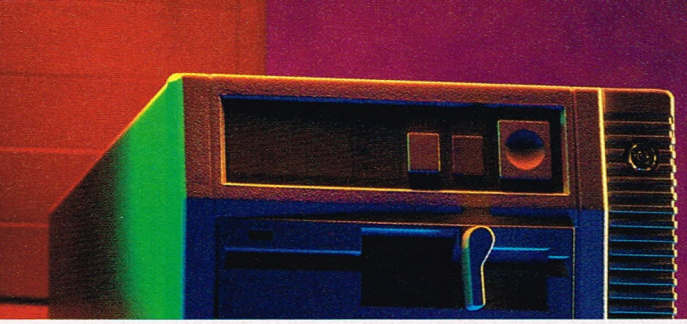


Figure 1: *The tree-copy test measures how well a drive copies a large directory structure; sequential tests gauge flat-out read and write throughput; and random tests exemplify application performance.* **(a)** *Under DOS, the Micropolis 1684 and the MicroNet Micro/Stack are notable for their excellent tree-copy and sequential-read throughput.* **(b)** *Under Unix, the FWB and Optima drives had superior overall results.* **(c)** *Although performance differences under NetWare 386 were less dramatic than those under DOS or Unix, drives from FWB, Optima, and MicroNet stood out again.* **(d)** *On the Macintosh, drive performance clustered quite tightly, although drives from Storage Dimensions and Micropolis turned in the best results overall. Longer bars indicate better performance.*



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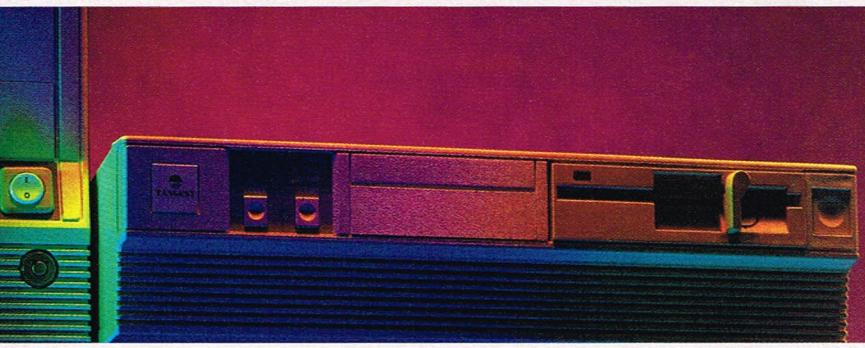
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moves on to the next request. The advantages of asynchronicity are not seen in single-drive configurations, such as those that appear in these tests. The real gains become apparent when you use advanced configurations such as *striping*, in which multiple disk drives are treated as one.

Unix Picks

The preceding information is meant to help you draw your own conclusions from the table, but we have our own favorites—some obvious, others less so.

The drives that fell in the "obvious choice" category surprised us. They were the ones that had it all: small size, external case and power supply, and near-silent operation. We didn't expect these tiny drives to be the top performers, but FWB's hammer300 and Optima's Diskovery 325 were clear winners in overall speed. We were also pleased with MicroNet's Micro/Stack, another small, silent drive. You have to pay for the convenience that reduced size brings—these drives are quite expensive for the storage they offer. The FWB drive holds a slight edge over the other small external drives in both price and performance, earning the nod for best in its class.

Heading up the big-drive category is the Storage Dimensions X/Stor system. This is actually up to four drives in a single case that can place over a gigabyte of storage at your system's disposal. The company has managed to construct a case that takes up barely more room than the drives themselves, and it is attractive enough that you won't be ashamed to have it seen on your desk.

The rest of the pack included a smattering of internal and external drives. Of these, the Micropolis half-height internal drive seemed to have the best overall showing. The only factors that would bring us to a heavy full-height drive would be performance and price, and the Micropolis 1684 makes both these arguments moot. At a suggested list price of $1995 for the bare drive, it's a good starting point for building a system. Western Digital's WD380 SC also performed quite well.

The Fujitsu full-height internal drive is this roundup's enigma: Its performance pushed it out of the top five, but it still managed to skunk the others in *only* the tree-copy test. This may be thanks to the drive's fast seek time, and the tree-copy test does a blessed lot of seeking. The drive's noise level was the worst of all the drives we tested, producing loud snaps during seeks and emitting an annoying whine during normal operation. Unless you plan to drop it in acoustic foam or in another room, save your ears the torment of the Fujitsu drive.

Another disappointment was the CMS Prevail 325 drive. Prevail it didn't, because, of all the drives in the test, the Prevail was the only one that wouldn't work with Unix. The very same drive and controller worked perfectly with DOS and NetWare, but when we attempted to install the drive under Unix, even the simple reading of the drive's geometry failed. We notified CMS of the problem, but the company was unable to provide a solution.

NetWare 386 Optimizations Boost Disk Performance



Photo 3: *Among NetWare 386 drives, the FWB hammer300, Optima Diskovery 325, and MicroNet Micro/Stack 404/LAN were outstanding.*

Only CMS, MicroNet, and Optima were offering NetWare 386 drivers for their drives by the time we went to press. We tested the other drives under NetWare 386 using the Adaptec Host Adapter and its supplied driver.

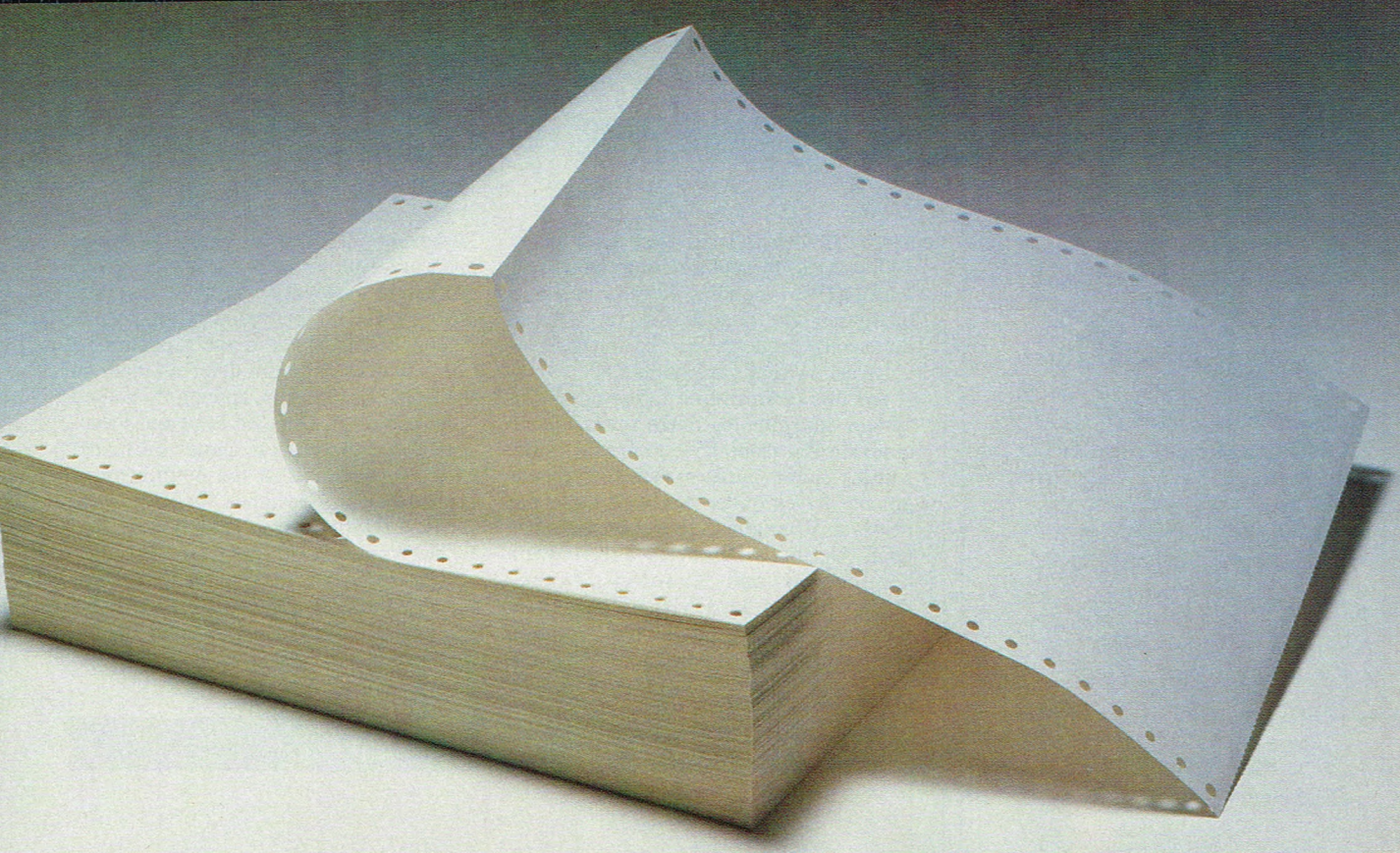
Installing these drives was easy, but that was due more to NetWare 386 itself than to any innovation on the part of the drive vendors. Once we cabled the drive to the host adapter, we just ran Novell's Server program and loaded the host adapter's driver, which each manufacturer supplies as an NLM (NetWare Loadable Module). A few floppy disk swaps are all that is required to install the remaining NetWare utilities onto the hard disk drive.

We didn't test these drives under Advanced NetWare, but you can expect a much more involved installation process with Advanced NetWare than with NetWare 386. The most time-consuming part of a NetWare installation often is running Novell's COMPSURF utility, which does a very detailed surface analysis to mark out defects. Some of the drives, including the ones from CMS and MicroNet, were "NetWare Ready" and didn't require COMPSURFing for any NetWare installation. NetWare Ready, a Novell certification, also indicates that some NetWare configuration information is already present on the disk; Advanced NetWare versions 2.15 and higher can read drive information directly off the disk and do not require additional drivers.

Each of these drive/host-adapter combinations supports NetWare's disk-mirroring capability, which reserves one disk as a copy of another to guarantee data integrity.

NetWare 386 and Unix have some similarities when it comes to managing disk drives. NetWare 386 keeps caching buffers for both files and directories, caching both reads and writes. NetWare and these host adapters also support SCSI disconnect, which provides performance gains in multiple drive configurations by allowing a controller to move on to other tasks while one drive is finding its data.

Some performance features, however, are unique to NetWare 386. The operating system makes a number of dynamic optimizations to crank up disk performance. NetWare dynamically allocates memory for directory cache buffers to tune them to the pattern of actual disk



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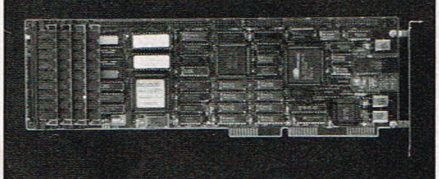
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usage. It also indexes files with many FAT entries, to speed random accesses. And NetWare handles elevator seeks, a technique that queues disk requests so that sector requests seen by the disk involve as few seeks as possible.

All this optimization in the operating system conspires to make performance quite similar from drive to drive. As the figures show, performance differences among drives under NetWare were not nearly as dramatic as those shown under DOS. Optima's Diskovery 325, FWB's hammer300, and MicroNet's Micro/Stack finished in a virtual dead heat when you consider both tree-copy and file read/write performance. Both the Diskovery 325 and hammer300 drives had shown good speed in our other environments, so it was no surprise that they did very well on the tree-copy test.

The Micro/Stack drive's optimizations, which made the drive a leader in the DOS benchmarks, apparently helped here, as well; it finished head and shoulders above the rest on sequential reads. MicroNet claims that the optimizations are specifically designed for better performance with the small block sizes used by NetWare.

The CMS Prevail 325, Western Digital WD380 SC, and Fujitsu M226 ISA scored quite well—only slightly behind the top three finishers.

Mac and SCSI: A Venerable Relationship



Photo 4: *The La Cie ZPF 300 shined for its economy, while the Micropolis 1684 and the FWB hammer300 turned in superior performance among Macintosh drives.*

Utility software played a key role in our evaluation of Macintosh drives. Although disk drives for other environments neither require nor supply utilities, drives on the Mac thrive on them. Mandatory components of the packages were disk formatting and disk partitioning utilities.

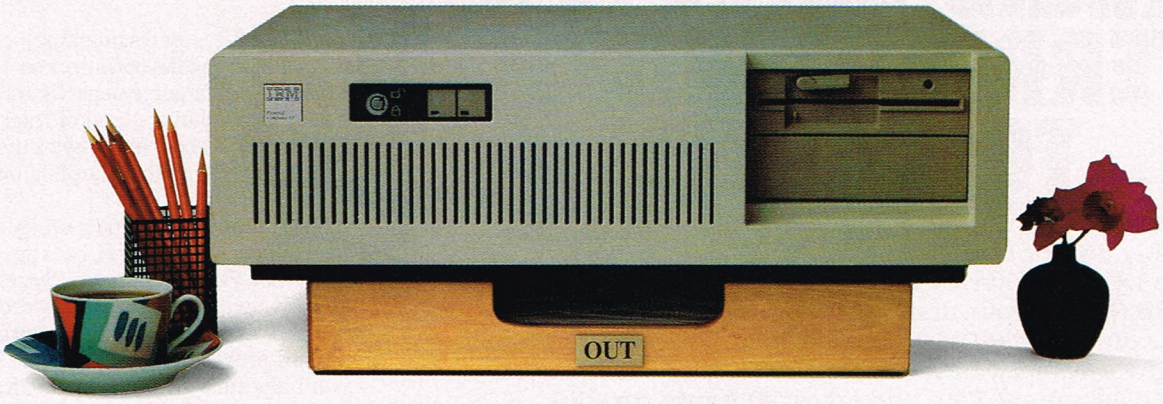
Disk formatting readies the hard disk surface for accepting data. Unusable sectors are usually located at this stage and mapped out. All the packages we tested either allowed you to select an interleave factor or picked one for you, based on the speed of the host machine.

Disk partitioning divides the physical disk surface into one or more logical volumes. Many of the manufacturers suggest that, for performance's sake, you limit partitions to around 80 MB. This stage also builds the initial directory structure (directory B-tree and bit maps) for the partition. Most of the systems we looked at supported A/UX partitions, as well as Mac OS partitions. A few supported ProDOS.

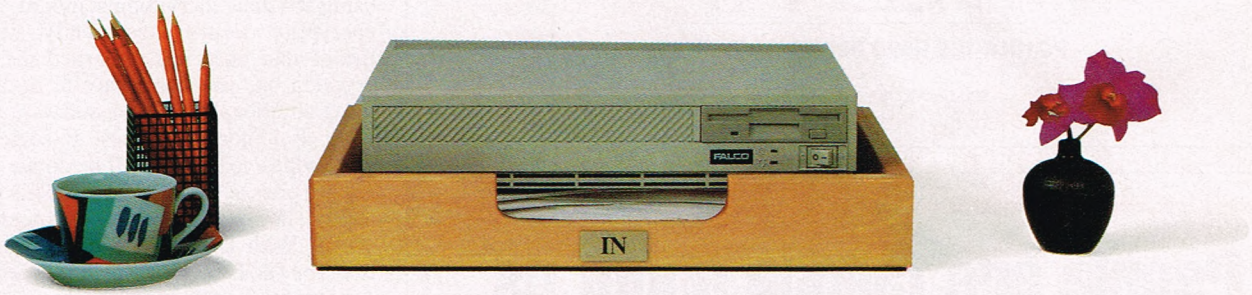
Before the Macintosh can access a volume (i.e., make it appear on the Desktop), you must *mount* the partition associated with that volume. Partitions on a Macintosh drive can be tagged to mount either at start-up time, called *automounting*, or in response to an explicit mount request. All the utility packages that we examined handled automounting. Additionally, all the packages allowed us to lock individual partitions; locked partitions are read-only, which offers some virus protection for sensitive applications. Finally, nearly every package provided some level of password protection.

Silverlining, the La Cie ZPF 300's accompanying driver software, included an autopark feature. It also provided a disk

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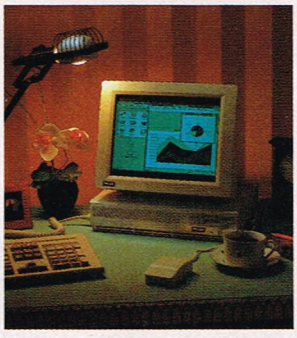


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optimizing (i.e., defragmenting) capability. Unleashing the optimizer on a volume shows you a percentage figure that indicates that volume's level of fragmentation, as well as how many bytes the optimizer will have to move around on the drive to clean things up.

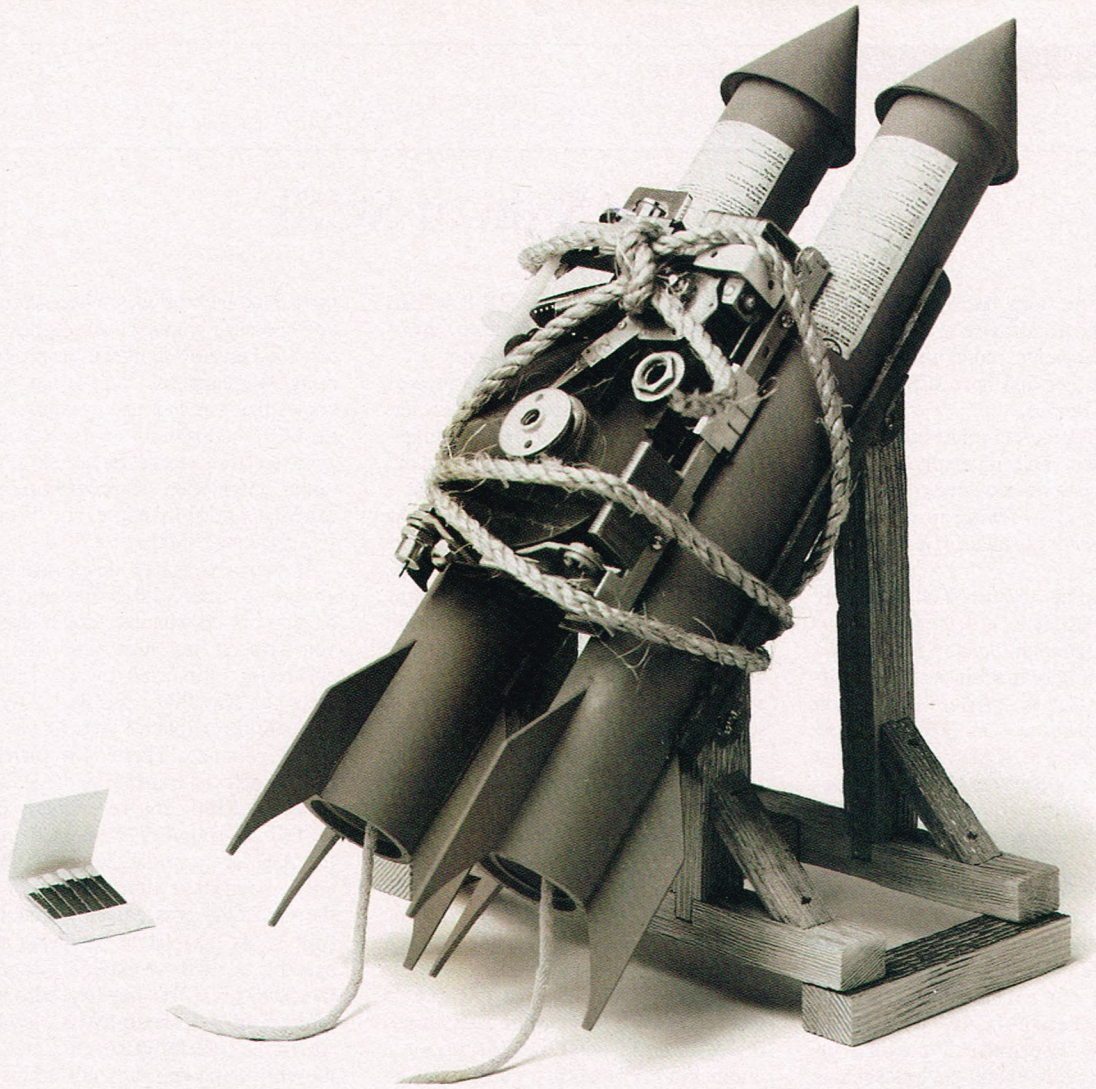
The Rodime Cobra 330e's utility software included FastBack II backup software (from Fifth Generation Systems). Although you can assign passwords to partitions on the Rodime drive, you can't password-protect a boot partition. This was mildly annoying, but it's critical if you don't want anyone to get into your machine.

The software with SuperMac's DataFrame is as extensive. You select the size of a disk's partitions using a unique, movable pie chart. Once you've built your partitions, not only can you attach individual passwords, but you can select partitions to be automatically encrypted using the data encryption standard. The encryption occurs transparently, which means that once you've turned the encryption on, you don't have to do anything additional—all your software will work as it normally does. If someone else swipes your drive, all he or she will see are piles of encrypted data. This protection, however, comes at the expense of speed. With DES activated on a partition, the file I/O tests that we ran yielded a sequential read throughput of about 28,000 bytes per second and a sequential write throughput of about 27,000 bytes per second. Compare this to the over 1 million bytes per second that we obtained on reads without DES.

FWB's hammer300 arrived with an impressive array of software: each program accompanied by a small manual. Not only can you password-protect and encrypt partitions on the fly, but FWB's Hard Disk Deadbolt software lets you perform after-the-fact encryption using the DES algorithm, as well as a faster proprietary encryption scheme called Quickbolt. Deadbolt also includes Blackout, a software utility that lets you temporarily lock your Mac for short trips away from your desk. You activate Blackout and enter a password, and your Mac is frozen until someone reenters that password. (And Blackout is intelligent about how it "freezes" your machine—background tasks can continue to run.)

Optima's software, which is called DiskMount, handles the essentials: formatting, partitioning, and attaching passwords to partitions. The password control can mount access to a partition, and you can specify that a partition remain locked until the proper password is

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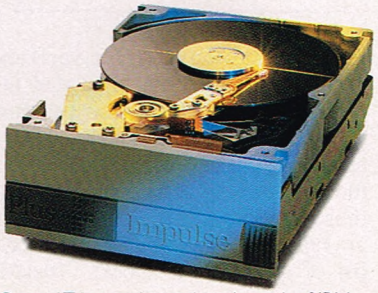
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The Fuzzy Side of SCSI

Communication between the SCSI bus and a disk drive or other device has two segments: computer to host-SCSI controller and host-SCSI controller to SCSI device.

The SCSI protocol makes the second step efficient and relatively painless, because every device speaks the same language, and switching in units from different vendors (ideally) presents no problems.

But computer to host-SCSI controller communication is a different story. Each host adapter vendor for the PC XT/AT family of machines shows a different interface to software running on the host machine. On SCSI-equipped Macs, the built-in SCSI chip means that there is only one way to talk to SCSI devices, but the programming method is radically different from anything seen on the PC.

Common Access Method promises to straighten out this uncivilized side of SCSI communication, at least for the PC. But the CAM committee hasn't yet hammered out a final standard. The standard that the CAM committee adopts may also make it possible for drivers for more exotic devices such as CD-ROMs, tape drives, and scanners to share the same host adapters through a common interface.

The BYTE Lab has been working on SCSI testing software designed for the Macintosh SCSI chip and three popular PC-host adapters: the Western Digital WD7000-ASC, the Adaptec AHA-1542B, and the Future Domain TMC-885. None of these devices makes writing software a terrible chore. But as far as we're concerned, writing for three interfaces is writing for two interfaces too many, which leaves us hoping for a well-defined CAM in the near future.

Western Digital's family of host adapters relies on the Standard Device Level Protocol interface developed by Columbia Data Products. SDLP defines commands for reading, writing, information gathering, and other tasks.

Under MS-DOS, software has access to SDLP through a software interrupt, INT 11 hexadecimal, which the adapter's ROM steals from the equipment determination routine in the machine's BIOS. To send a SCSI command, the calling software simply fills registers with appropriate values and fires off the interrupt. OS/2 and Unix applications access similar commands through `ioctl` calls to the SDLP kernel device driver, which in turn talks to the host adapter hardware through an adapter-specific device driver.

The Advanced SCSI Programming Interface provides Adaptec's host adapters with a common software interface for device drivers and applications. DOS, OS/2, and NetWare applications talk to the ASPI driver by pushing the address of a command block onto the stack and then issuing a `call` to the driver. The process differs between the operating systems only in the way in which the calling software determines the ASPI entry point. ASPI supports a number of information request calls and standard SCSI I/O commands.

Future Domain provides developers with an OEM kit to ease the process of writing software that supports Future Domain host adapters. The kit consists of object modules that developers can link into their own code. We also found it relatively easy to write directly to the card's TMC-950 SCSI controller chip, a memory-mapped device for which Future Domain provides documentation.

On the Mac, you can take comfort in there being only one programming interface to SCSI: the Mac's SCSI manager. Unless you're trying to do some *real* low-level SCSI programming, the SCSI manager provides all the functions that you need. The SCSI manager supports bus arbitration, device selection, and message transfer. Apple has even provided an extremely simple programming language for high-speed buffer copies that you can use to control what the SCSI manager does with data sent to or taken from a target device. (For a detailed description of programming to the Mac's SCSI manager, see "Foreign File Systems," March BYTE.)

If you are really desperate to go straight to the SCSI hardware, you'll have to dig up whatever documentation you have on the NCR 5380, the SCSI controller chip used by Macintoshes since the Mac Plus. You'll also want to go spelunking into all your *Inside Macintosh* volumes. There is a variety of ways to effect a transfer on the SCSI bus using the 5380. You've probably heard of "blind" transfers: data exchange on the SCSI bus in which the system checks only a handshake bit in association with the first byte of a packet transfer and then sends the rest of the bytes at top speed (i.e., without explicitly checking handshaking). You may have also heard of the 5380's "pseudo-DMA" mode, in which the transfer of bytes to and from the chip triggers the handshaking signals on the SCSI bus.

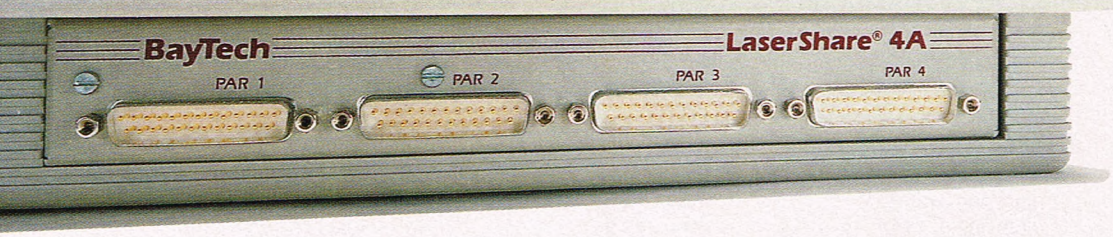
As compatible as Macs may seem, the sad truth is that even though all Macs use the 5380 to control the SCSI bus, the 5380 is wired differently for different Macs. For example, in a Mac Plus, the base address of the 5380 is at 580000h; it's at 5FF000h on a Mac SE and at 50F10000h on the Mac II. Furthermore, the Mac Plus must use software handshaking in the pseudo-DMA mode, which means that you might run into invalid data being transferred if you choose to use blind transfers on that machine.

The moral: Unless you're developing your own custom SCSI hardware, stick with the SCSI manager.

given. DiskMount's disk verification performs a nondestructive read test of the hard disk surface. You can specify that the disk drive's internal error correction be turned off for the duration of the test so that "marginal" blocks (i.e., those likely to fail soonest in the future) are reported. Once you've collected your list of questionable blocks, DiskMount lets you map good blocks in the place of bad ones. As an extra level of protection, the Optima system keeps duplicates of the disk's partition information and device driver. In that way, if either should somehow become corrupted, a utility program called QuickFix can replace the original with the duplicate.

The installation software on Storage Dimensions' MacinStor isn't loaded with frills, but it has everything you need. You can password-protect partitions, toggle them as read-only, and even flag a partition to use write verification. We were also very happy to see that the MacinStor disk included a cdev (a Control Panel device) version of the installation software. This allows you access to the

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A-Line Dataspeed Devices, Ltd.
0533-778899

Buckinghamshire
Trend Datalink, Ltd.
(06285) 30611

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COMPANY INFORMATION

Adaptec, Inc.
(AHA-1542B)
691 South Milpitas Blvd.
Milpitas, CA 95035
(408) 945-8600
Inquiry 1111.

CMS Enhancements
(Prevail 325)
1372 Valencia Ave.
Tustin, CA 92680
(714) 259-9555
Inquiry 1112.

Core International
(SLAN 310)
6500 East Rogers Cir.
Boca Raton, FL 33487
(305) 997-6033
Inquiry 1113.

FlexStar
(3000s)
2040 Fortune Dr.
San Jose, CA 95131
(408) 433-0770
Inquiry 1114.

Fujitsu America
(M226 ISA)
3055 Orchard Dr.
San Jose, CA 95134
(408) 432-1300
Inquiry 1115.

Future Domain
(TMC-885)
1582 Parkway Loop, Suite A
Tustin, CA 92680
(714) 259-0400
Inquiry 1116.

FWB
(hammer300)
2040 Polk St., Suite 215
San Francisco, CA 94109
(415) 474-8055
Inquiry 1117.

La Cie
(ZPF 300)
19552 Southwest 90th Court
Tualatin, OR 97062
(800) 999-0143
(503) 692-0771
Inquiry 1118.

MicroNet Technology, Inc.
(Micro/Stack 404/LAN,
Micro/Stack MS-404)
20 Mason
Irvine, CA 92718
(714) 837-6033
Inquiry 1119.

Micropolis Corp.
(1684)
21211 Nordhoff St.
Chatsworth, CA 91311
(818) 709-3300
Inquiry 1120.

N/Hance Systems, Inc.
(HCS300E)
908R Providence Hwy.
Dedham, MA 02026
(800) 289-9676
(617) 461-1970
Inquiry 1121.

Optima Technology
(Diskovery 325)
17526 Von Karman
Irvine, CA 92714
(714) 476-0515
Inquiry 1122.

Priam Systems
(ED 330 SC)
1140 Ringwood Court
San Jose, CA 95131
(408) 954-8680
Inquiry 1123.

Rodime Systems, Inc.
(Cobra 330e)
901 Broken Sound Pkwy., NW
Boca Raton, FL 33487
(407) 994-5585
Inquiry 1124.

Storage Dimensions
(MacinStor MAC325-S1,
X/Stor xsh1-330S1)
2145 Hamilton Ave.
San Jose, CA 95125
(408) 879-0300
Inquiry 1125.

SuperMac Technology
(DataFrame)
485 Potrero Ave.
Sunnyvale, CA 94086
(408) 245-2202
Inquiry 1126.

Western Digital
(WD380 SC, WD7000-ASC)
8105 Irvine Center Dr.
Irvine, CA 92718
(714) 932-5000
Inquiry 1127.

most frequently used functions, such as mounting or dismounting a partition from the Control Panel. The MicroNet installation software builds A/UX as well as Macintosh partitions, and it easily initialized drives.

MicroNet drivers supported overlapping seeks on multiple disk drive configurations. Overlapping seeks logically chain two drives together and divide data between them. The process makes use of the drive's built-in read-ahead cache. For example, if software issues a large read request on a file (e.g., a multimegabyte image file), the first piece of the file comes from drive A, the second from drive B. MicroNet's engineers point out that even write accesses benefit from overlapped seeks: Since each drive fills up half as fast as it ordinarily would, seek distances are reduced.

It's not easy to pick the best Macintosh drive. In general, a winner in one test turned in a mediocre performance in other tests. Based on performance alone, we chose the Micropolis 1684 as the top drive because of its write throughput numbers (see figure 1). It scored the highest marks in both our sequential- and random-write throughput tests. (Because this was an OEM drive, we needed compatible driver software; we used La Cie's Silverlining in our tests.)

However, when we considered more than just raw speed, we gave top honors to the FWB hammer300. Although not a speed demon, it ranked in the top half of most tests. The amount of support software that came with the drive swayed our vote.

Finally, if you're cost-conscious and find yourself reeling from high prices, consider the La Cie ZPF 300 drive. It scored near the middle in most tests, and its Silverlining software, while not replete with features, is probably all the hard disk drive software you'll ever need. However, the drive stands out in price: It's $700 to $2500 less than other Mac drives.

And the Winner Is...

Picking an overall high-capacity hard disk drive winner depends, as always, on your individual application and environment. The FWB and Optima drives proved to be very solid. Both finished at or near the top for all four operating systems. Although it is slickly packaged and well documented, the Optima Diskovery 325 is too expensive for our tastes; we like the FWB hammer300 for both its price and performance.

Storage Dimensions' offerings turned out to be excellent performers, as well. Both the X/Stor and the MacinStor scored very well on their respective Unix and Macintosh platforms, and both carry prices lower than drives of similar performance and capacity.

If your platform is DOS or NetWare, we suggest MicroNet's Micro/Stack 404/LAN. At 423 MB and with excellent benchmark numbers, the $4495 Micro/Stack may be worth the little larger up-front investment.

All the OEM drives had acceptable speed, but the Micropolis 1684 distinguished itself. Each drive had above-average mean-time-between-failure ratings, and the speedy Western Digital WD380 SC, at 3½ inches, fits in where others can't. ■

Steve Apiki and Stan Wszola are BYTE Lab testing editors/engineers. Rick Grehan is the BYTE Lab technical director, and Tom Yager is a BYTE Lab technical editor. They can be reached on BIX as "apiki," "stan," "rick_g," and "tyager."

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REVIEW

High-Performance 486 ATs

With all the coverage that the Extended Industry Standard Architecture (EISA) and Micro Channel architecture buses get, it's easy to believe that you need one of these new bus architectures to get great performance. Not necessarily. The three machines in this review—AST's Premium 486/33, Club American's Hawk III, and Everex's Step 486/33—combine a 33-MHz i486 with the standard AT bus, and the result in each case is a screamer.

These three machines also have a lot in common besides the AT bus and the 33-MHz i486 CPU. All contain a socket for a Weitek WTL4167 math coprocessor, a 5¼-inch 1.2-megabyte floppy disk drive, two serial ports, a parallel port, a 101-key keyboard, a 16-bit VGA card with 256K bytes of RAM, and a 14-inch color monitor. The main differences in the configurations that we tested were the size of the hard disk drive and the amount of RAM and external cache memory that each offered.

The Premium 486/33 had a 3½-inch 110-MB Imprimis Intelligent Drive Electronics (IDE) hard disk drive with a 16-millisecond average access time, 4 MB of system RAM, and no external CPU cache. The Hawk III had a 5¼-inch 158-MB Maxtor ESDI hard disk drive with a 16-ms average access time, 8 MB of RAM, and 256K bytes of external cache memory. The Step 486/33 had the greatest disk capacity of the group, with a 5¼-inch, 330-MB, 14½-ms Seagate ESDI hard disk drive, as well as 8 MB of RAM and a 128K-byte external processor cache. The Step 486/33 and the Hawk III also had multifrequency monitors, rather than the standard VGA monitor that was included with the Premium 486/33.

Because the configurations of these machines are so similar, it can be difficult to choose among them. The key is to focus on three major criteria: price, performance, and reliability.

Wide Price Spread

None of these systems is cheap, but you can't expect bargain-basement prices for top performers. To make a reasonable price comparison, we priced each system with a color VGA board and monitor, a 150-MB hard disk drive (or one as close to that size as possible), and 4 MB of RAM. In that configuration, the Everex Step 486/33 with a 160-MB drive is the most expensive of the group, with a list price of $11,899. A comparable AST Premium 486/33 with a 110-MB drive costs $10,619, which is roughly 10 percent less.

If price is your only consideration, however, you can read this paragraph and skip the rest of the review. The Hawk III in our comparison configuration costs only $6989, and that's with a 158-MB drive. The others just can't compete with the Hawk III's rock-bottom mail-order price, even considering typical dealer discounts for the Premium 486/33 and Step 486/33.

AST's Premium systems have one unusual advantage over the others: You can start with a slower CPU and later upgrade to the 33-MHz i486, or whatever chip is the fastest Intel CPU at the time. Still, the price difference between the AST Premium 486/33 and the Club American Hawk III is too much to pay just for the upgrade privilege.

Fast, But Not the Fastest

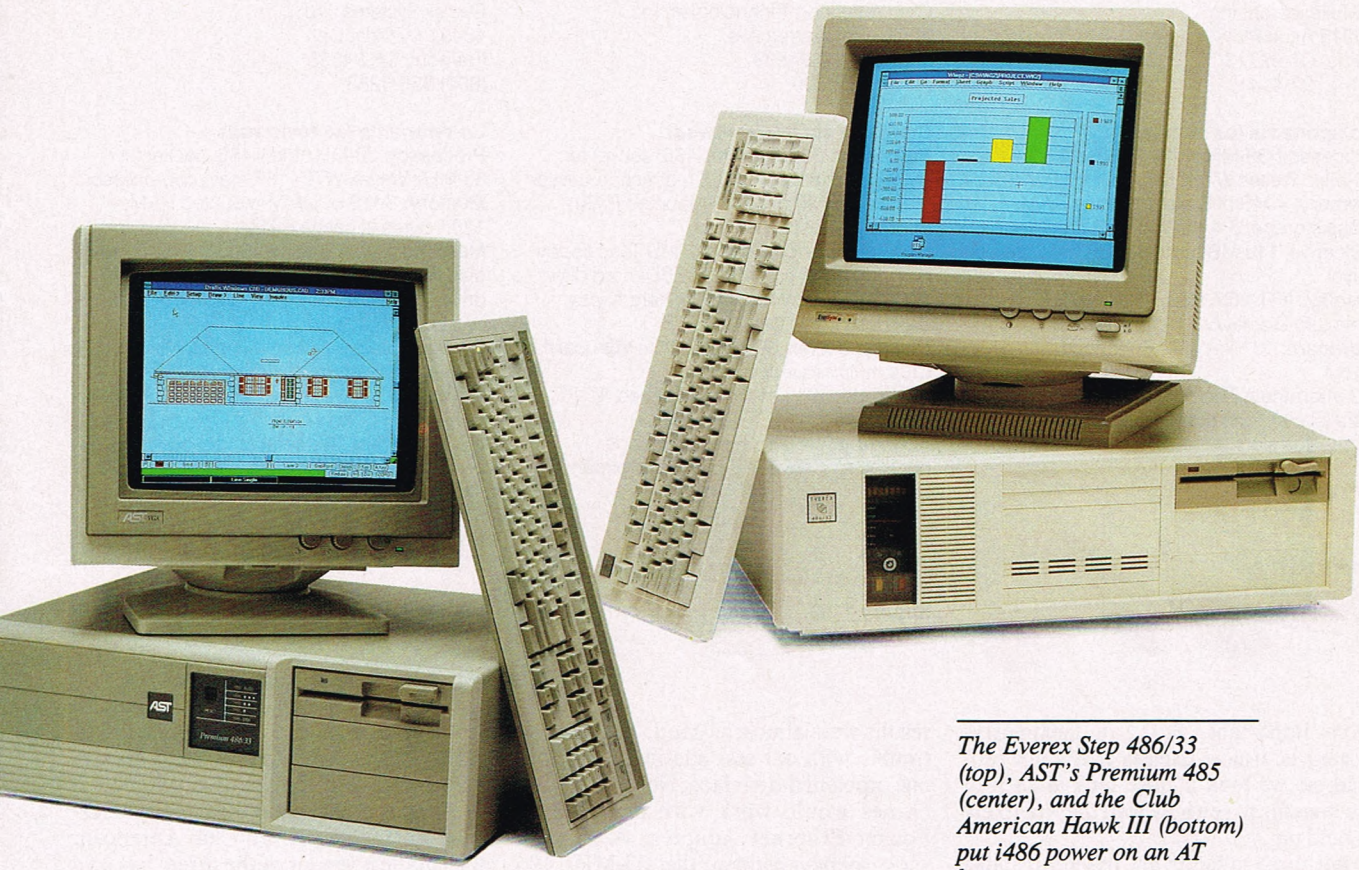
Price comparisons are fair only when the systems involved perform at about the same level. As the graph shows, these three systems definitely make price comparisons reasonable, because they produce very similar results on the BYTE benchmarks. On the overall DOS application index, the fastest machine of the bunch, the AST Premium 486/33, is less than 10 percent faster than the slowest, the Hawk III—there's not a dog in the group.

Still, none of them even comes close to the 65.2 application index of the Tangent Model 425 EISA bus machine that we reviewed last month—and the Tangent uses only a 25-MHz i486 CPU! To resolve this discrepancy, here's a closer look at the benchmark results.

On the CPU front, the Step 486/33, with a score of 9.0, is the clear winner. Its score is over 20 percent better than the 7.4 of the Hawk III and the 7.2 of the Premium 486/33. The Step 486/33 gets its strong CPU score primarily from Everex's Advanced Memory Management Architecture cache controller, which manages the system's external 128K-byte, 20-nanosecond static RAM (SRAM) cache.

By forgoing an external cache and relying solely on the i486's internal cache, the Premium 486/33 turned in the lowest CPU performance of the group. The Hawk III, like the Everex system, has an external cache. In fact, its 256K-byte cache of 20-ns SRAM is twice the size of the Step 486/33's. Because the Hawk III's larger cache didn't give it the CPU performance crown, we can only conclude that Everex's AMMA cache controller must be better than the Hawk III's cache manager.

CPU speed isn't the entire story, however, because all three machines beat the Tangent's 6.6 CPU score, and yet lost to the Tangent by a substantial margin in overall application-level performance. The answer, not surprisingly, lies pri-



The Everex Step 486/33 (top), AST's Premium 485 (center), and the Club American Hawk III (bottom) put i486 power on an AT bus.

marily in disk performance.

All three systems have less than spectacular disk scores. The slight edge goes to the Step 486/33, with a score of 3.2 on the low-level disk tests. The Hawk III and Premium 486/33 were close behind, at 3.0 and 2.3, respectively.

None, however, has a caching hard disk drive controller, and that's where the Tangent machine gets its performance. The Tangent's BYTE disk index of 10.1 is due, in large part, to its Mylex caching disk drive controller, with 4 MB of on-board RAM. The lesson is clear: If maximum performance is your goal, get a caching disk drive controller.

The Unix benchmark suite produced slightly different results. Here the Hawk III came out on top, neck and neck with the Step 486/33. Lower results in the System Loading and Tower of Hanoi tests dragged the Premium's cumulative index down to third place.

The Ratings

With performance so close, the Hawk III's price advantage looks more and

Premium 486/33 Model 115

Company
AST Research, Inc.
16215 Alton Pkwy.
Irvine, CA 92713
(714) 727-4141

Components (as reviewed)
Processor: 33-MHz Intel i486; socket for 33-MHz Weitek WTL4167 math coprocessor
Memory: 4 MB of SIMM-mounted RAM
Mass storage: 5¼-inch 1.2-MB NEC floppy disk drive; 110-MB Imprimis IDE hard disk drive
Display: AST-VGA Plus 16-bit card; AST Premium Display/VGA color monitor
Keyboard: 101-key IBM Enhanced AT layout
I/O interfaces: Two serial ports; one parallel port; one 8-bit and six 16-bit AT-bus expansion slots

Price
$10,619

Inquiry 1108.

Hawk III

Company
Club American Technologies, Inc.
3401 West Warren Ave.
Fremont, CA 94539
(415) 683-6600

Components (as reviewed)
Processor: 33-MHz Intel i486; socket for 33-MHz Weitek WTL4167 math coprocessor
Memory: 8 MB of SIMM-mounted RAM; 256K bytes of cache RAM
Mass storage: 5¼-inch 1.2-MB Teac floppy disk drive; 158-MB Maxtor ESDI hard disk drive; Data Tech 16-bit ESDI hard/floppy disk drive controller
Display: Everex Viewpoint 16-bit VGA card; Club multifrequency monitor
Keyboard: 101-key IBM Enhanced AT layout
I/O interfaces: Two serial ports; one parallel port; seven 16-bit AT-bus expansion slots

Price
$7674

Inquiry 1109.

Step 486/33

Company
Everex Systems, Inc.
48431 Milmont Dr.
Fremont, CA 94538
(800) 356-4283

Components (as reviewed)
Processor: 33-MHz Intel i486; socket for 33-MHz Weitek WTL4167 math coprocessor
Memory: 8 MB of SIMM-mounted RAM; 128K bytes of cache RAM
Mass storage: 5¼-inch 1.2-MB Teac floppy disk drive; 330-MB Seagate ESDI hard disk drive; Everex 16-bit ESDI hard/floppy disk drive controller
Display: Everex Viewpoint 16-bit VGA card; Everex multifrequency monitor
Keyboard: 101-key modified IBM Enhanced AT layout
I/O interfaces: Two serial ports; one parallel port; one 8-bit and six 16-bit AT-bus expansion slots

Price
$13,499

Inquiry 1110.

more important. Still, an inexpensive system is almost useless if it's not reliable, so we took a close look at each of the systems to see how well they're likely to hold up.

All three systems are based on stable architectures that their vendors have used in previous machines. Nonetheless, all three have change wires on the backs of their motherboards, with the Step 486/33's nine wires the worst of the bunch. We had no trouble with any of the systems, but the motherboards clearly could stand one more cleanup iteration.

All three motherboards also depend heavily on discrete logic rather than application-specific ICs, which are common in more mature machines. All three boards have the telltale signs of early designs, with over 100 chips on each board (many of which are socketed) and almost no surface mounting. The vendors had no choice—as we've noted before, they are ahead of the chip-set makers—but 486 systems are likely to become cheaper and more reliable when i486 support chips become commonly available.

A reliable system not only must stay up, it also must be able to run the programs you expect it to run and work with the boards you plan to put into it. These three machines did well on the first front, running over two dozen test applications without a hitch. Their hardware results were almost as good. They had no trouble with our test add-in boards, but one problem did surface: None of the machines would work with our Xircom Pocket Ethernet Adapter. A Xircom spokesperson claimed that 33-MHz 486 systems are sometimes too fast for the Pocket Ethernet Adapter's control logic. Xircom fans can relax, though; Xircom is preparing a patch that should be available before this review sees print. Still, this problem serves to indicate the unusual difficulties that sometimes lurk in leading-edge systems.

Another aspect of reliability that you must consider is what to do when something goes wrong with the system. All three vendors offer the same basic solution to this problem: a one-year parts-and-labor warranty that requires you to ship the broken system or part to the vendor for repair. Service for the Premium 486/33 is also typically available from the nearest AST dealer.

Everex is the only one of these vendors that gives you the choice of on-site service as well. We've heard some computer vendors gripe about the quality of the on-site service from national third-party service firms, but we still think that systems as powerful as these three should come with on-site service.

The final reliability concern that any buyer—but particularly those in large organizations—must consider is the reliability of the vendor itself. The best service contract in the world is no good if the vendor offering it will be gone tomorrow. Fortunately, even Club American, the smallest vendor of the three, has sold over 200,000 systems and has annual sales of over $250 million. No computer company is ever entirely safe, but these firms seem to have the critical mass necessary to stay in business long enough to fix any problems that you're likely to encounter.

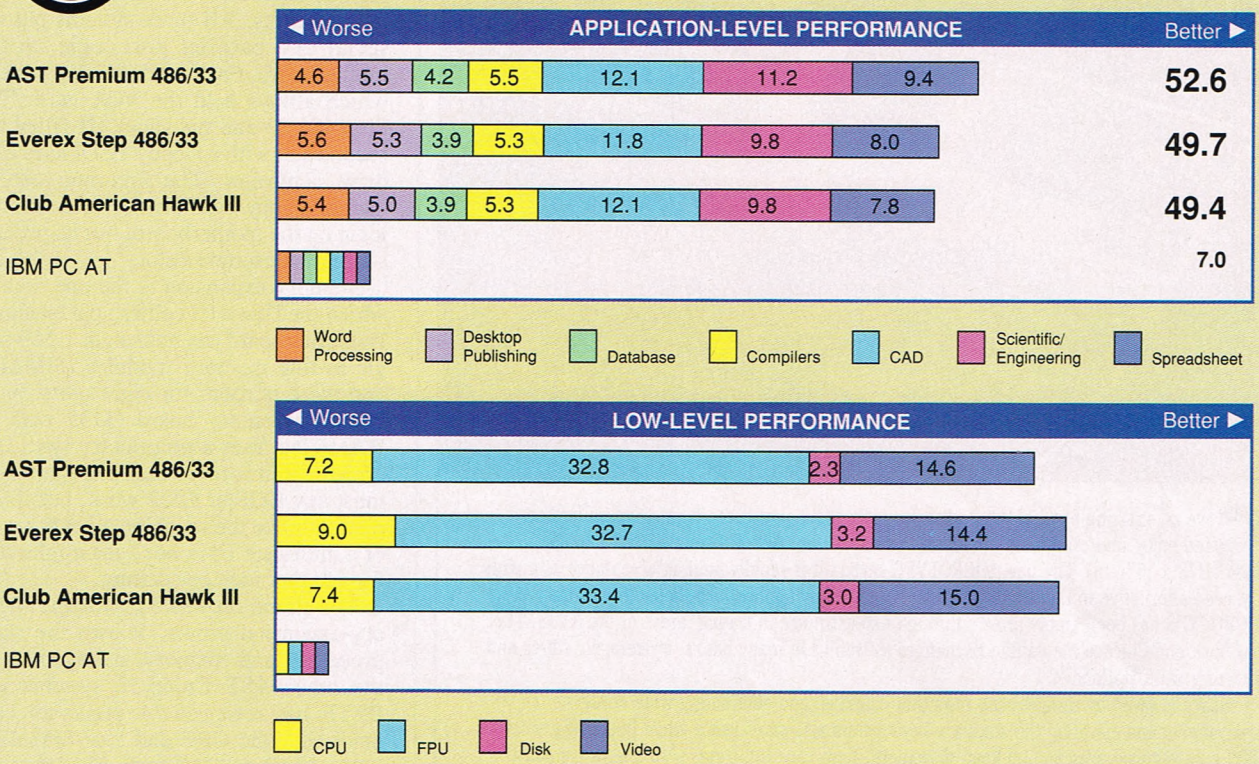
Extra Points

One kind of problem that can occur even in perfectly functioning systems is lack of room to grow. You never know when you'll need more disk storage space, expansion slots, or memory.

All three systems have reasonable disk expansion space, but here again, the Hawk III is the clear winner. Its floor-standing tower case is cavernous, with one full-height and five half-height 5¼-inch bays in front. If that's not enough, there's room for another full-height 5¼-inch drive on an arm that swings out behind the other drive bays.

The other two systems, by contrast, are more traditional desktop units. Each has five half-height 5¼-inch bays. With one of those bays dedicated to the floppy disk drive, each system can hold only two

DOS BENCHMARKS



CONVENTIONAL BENCHMARKS

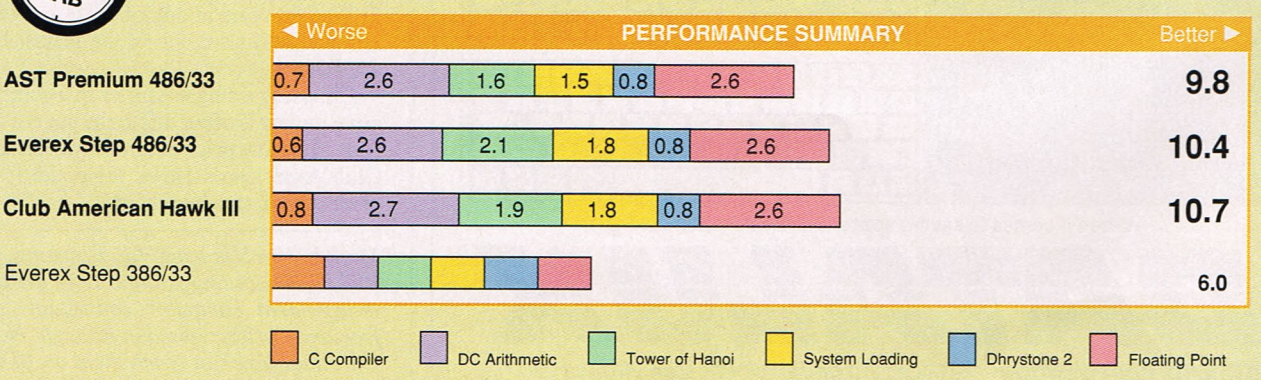
	LINPACK (single) (MFLOPS)	Dhrystones (Dhry./sec.)
AST Premium 486/33	0.8947	25849.4
Everex Step 486/33	0.8959	26912.9
Club Hawk III	0.9263	27472.3
IBM PC AT	0.0210	2317.9

For application and low-level benchmarks, results are indexed and show relative performance; for each individual index, an 8-MHz IBM PC AT running MS-DOS 3.30 = 1. For all benchmarks, higher numbers indicate better performance.

The BYTE low-level benchmark suite identifies performance differences between machines at the hardware level; the application benchmarks evaluate real-world performance by running a standard test suite using commercially available applications. Application indexes include tests using the following programs: Word processing: WordPerfect 5.0; Desktop Publishing: Aldus PageMaker 3.0; Database: Borland Paradox 3.0 and Ashton-Tate dBASE IV; Compilers: Microsoft C 5.1 and Turbo Pascal 5.5; CAD: AutoCAD release 10 and Generic CADD level 3 1.1.5; Scientific/Engineering: Stata release 2, MathCAD 2.5, and PC-Matlab 3.5f; and Spreadsheet: Lotus 1-2-3 release 3.0 and Microsoft Excel 2.1.

The BYTE Lab introduced version 2.0 of the DOS benchmarks in the August issue (see "BYTE's New Benchmarks: New Looks, New Numbers"). Benchmark results for machines reviewed under previous versions aren't directly comparable. To obtain a copy of the benchmarks, join the listings area of the byte.bmarks conference on BIX or contact BYTE directly.

UNIX BENCHMARKS



Note: The graph above summarizes the results of the Unix benchmarks (version 2.6). All results are indexed to show relative performance; for each test, an Everex Step 386/33 running Xenix 2.3.1 = 1. The cumulative index is formed by summing the indexed performance results for the tests. Comprehensive results are available by contacting BYTE.

full-height devices.

The three systems are identical when it comes to expansion slots. Each has seven AT-bus slots, five of which were open in our test units. All three systems put the serial and parallel port logic on the motherboard. Each used two slots, one of which always held the VGA card. The Step 486/33 and the Hawk III filled the second slot with a floppy/ESDI hard disk drive controller. The Premium 486/33 had its floppy/hard disk drive controller logic on the motherboard, but its processor card consumed a slot.

Memory expansion is the one area in which the Hawk III comes up a bit short. Its motherboard can hold eight 1-MB single in-line memory modules (SIMMs), and there is room for eight more on an optional memory board ($135 with no RAM) that uses a proprietary slot. This 16-MB limit is more than enough for almost any DOS or OS/2 work, but if you plan to make the machine a LAN server or a multiuser Unix box, you might wish for a higher memory ceiling.

The Premium 486/33 wins the memory-expansion crown. It uses the same processor and memory arrangement as the other AST Cupid-32 systems that BYTE has reviewed. A processor card holds the i486 CPU and four SIMMs of either 1 MB or 4 MB each. The Premium 486/33 also can accommodate up to two 32-bit memory cards (which cost $500 each, including 1 MB of RAM). Each card can house 16 1-MB SIMMs, for a maximum possible memory configuration of 48 MB.

The Step 486/33 is in the middle of the group, with a maximum of 32 MB of RAM. A single memory board, which goes into a proprietary expansion slot, can hold either 16 1-MB SIMMs or eight 4-MB SIMMs.

The high performance of these machines supports a claim that we've been making for some time: There's no reason to go to an EISA system unless you need a specific EISA card. Put a caching disk drive controller in any of these systems, and you will have one of the fastest PCs available.

Choosing a single winner in a comparative review is often difficult, but not this time. The low price and roomy cabinet of Club American's Hawk III make it the clear pick of this bunch. ■

Mark L. Van Name and Bill Catchings are BYTE contributing editors. Both are also independent computer consultants and freelance writers based in Raleigh, North Carolina. You can reach them on BIX as "mvanname" and "wbc3," respectively.

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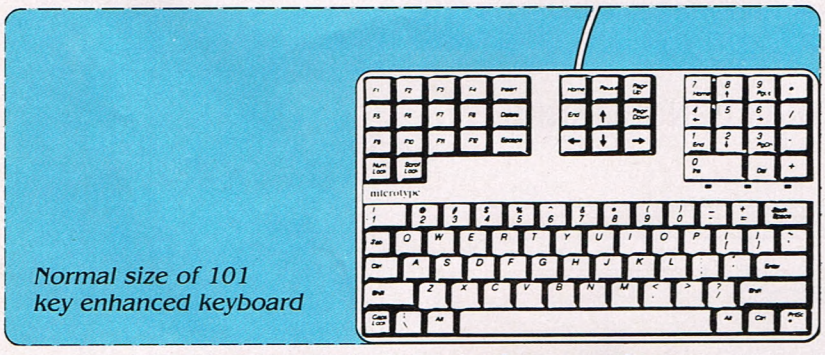
Space is saved by compressing rows (not columns) and eliminating wide borders. Re-arranging and elevating the auxiliary key clusters also saves space while improving accessibility with reduced eyescan and head movement. Keys have full travel with a light tactually responsive touch. All standard features such as auto-repeat, caps, num and scroll lock are included on the MICROTYPE.

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EUROPE	44 + 306-76718	Fax 44 + 306-76742	£99.00 + VAT + P&P	



Normal size of 101 key enhanced keyboard

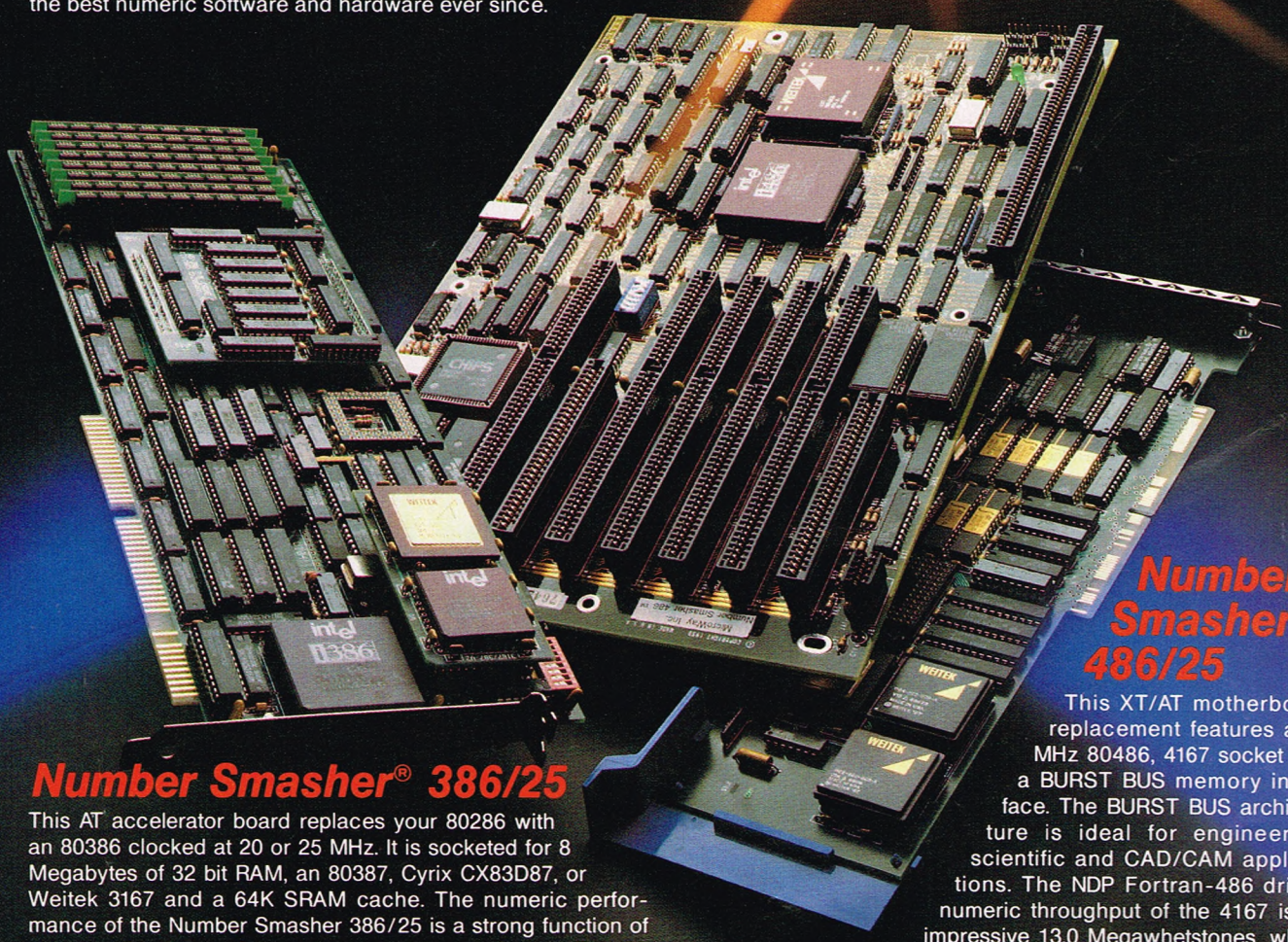
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Megawhetscales	4.1	9.9

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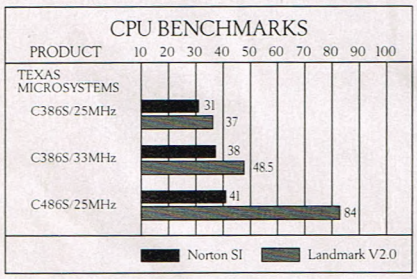


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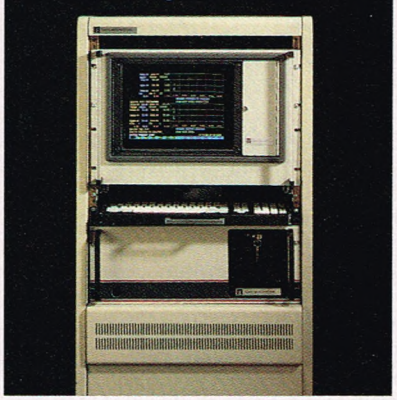
- Dimensions: 6.5" x 17" x 16.5", 30 lbs.
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  Temperature: 0°C to 55°C. (32°F to 131°F)
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Model	CPU/ MHz-RAM	Storage	Price
4216	286/16-1	40MB HD, 1.2 or 1.44MB floppy	$2,900
4320	386/20-1	40MB HD, 1.2 or 1.44MB floppy	$3,755
4325	386/25-1	104MB HD, 1.2 or 1.44MB floppy	$4,530
4333	386/33-2	104MB HD, 1.2 or 1.44MB floppy	$5,135
4425	486/25-4	104MB HD, 1.2 or 1.44MB floppy	$5,995

*From $2,900. Monitor not included.

$3,825*



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  Temperature: 0°C to 55°C. (32°F to 131°F)
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  Vibration: .25G, 5-100Hz operating
  5G, 5-100Hz non-operating
  Shock: 1.0G operating at 10 Msec duration

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3320	386/20-1	40MB HD, 1.2 or 1.44MB floppy	$4,650
3325	386/25-1	104MB HD, 1.2 or 1.44MB floppy	$5,430
3333	386/33-2	104MB HD, 1.2 or 1.44MB floppy	$6,040
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REVIEW

FPU Face-Off

Sometimes there's no way out. Unless you want to fossilize in front of your PC waiting for that CAD drawing to complete, a math coprocessor is your only hope. Not long ago, the only choice was to buy an Intel coprocessor. No longer. Several coprocessor vendors now are trying to fill that empty socket next to your 286, 386, or i486.

Whether you have a 286-, 386-, or i486-class machine, you've probably got at least one application—possibly a critical one—that could use the kind of speed boost that only an FPU can give. CAD and other scientific and engineering programs, spreadsheets, and, to a lesser extent, some database programs, can benefit from an FPU.

I looked at a sampling of coprocessors for 286- , 386- , and i486-class machines that should fit anybody's needs. The 80287-class chips include the 80287XL from Intel, the 80C287 from Advanced Micro Devices (AMD), and the 2C87 from Integrated Information Technology. The 80387-class chips include the Intel 80387DX, the Cyrix FastMath 83D87, the IIT 3C87, and the Weitek Abacus 3167. In the i486 arena, I measured the Weitek Abacus 4167 against the i486 CPU's built-in FPU. I then rounded up a group of test machines and put the FPUs through a battery of tests (see the figure). Before reviewing the test results, though, you'll want to understand how these FPUs work and the features that differentiate each chip from its competition.

Intel

Intel hasn't been sitting on its laurels; while other vendors have been introducing 80287 and 80387 clones, Intel has quietly refined its own FPUs. Its new 80287XL and 80387DX chips run substantially faster than the chips the company shipped just six months ago.

Intel's 80287XL, the successor to Intel's 80287, is an 80387 in 80287 clothing. Though hardware-compatible with the 80287, the 80287XL incorporates the numerics core of the 80387 coprocessor family. This means that you can access all the 80387's advanced instructions. However, your applications software must be aware of the 80287XL to take advantage of its added capabilities. But from a developer's standpoint, it's easy to construct a routine that detects the presence of an 80387-class coprocessor by carrying out a prescribed set of operations and examining the results. Best of all, the 80287XL is a CMOS component. It consumes about one-third the current of a standard 80287 and is 50 percent faster, according to Intel.

Intel's 80387 needs no introduction: It's at work in more 386 systems than any other coprocessor. The new 80387DX chip, introduced earlier this year, takes advantage of an improved chip manufacturing process that Intel claims provides 20 percent faster performance than its predecessors. The 80387 is a direct descendent of Intel's 80287 and 8087 coprocessors. However, the 80387 carries an improved instruction set. Some improvements are minor, while others are an application builder's dream. In particular, the 80387 beefs up trigonometric functions, which are particularly critical to two-dimensional and 3-D CAD applications.

Intel's 25-MHz i486 processor looks much like a 386/80387 combination. In the tests I ran, there's a significant performance hike between the 386/80387 and the i486, thanks to the integration of the coprocessor into the CPU. (For more on the i486, see "The 80486: A Hardware Perspective," *IBM Special Edition*, Fall 1989.)

AMD

At press time, AMD only offered 80287-class coprocessors. Its 80C287 is more or less a faithful reproduction of the Intel 80287. Like Intel's 80287XL, it has CMOS internals, so power consumption is less than that of a typical 80287: At 10 MHz, the AMD 80C287 consumes about 100 milliamperes of current, while a stock 80287 takes somewhere in the neighborhood of 400 mA.

The AMD 80EC287, which I did not test for this review, is essentially an 80C287 with a low-power sleep mode. The 80EC287 enters sleep mode whenever the coprocessor isn't executing an instruction. In this mode, the 10-MHz version draws only about 10 mA. Both the 80C287 and 80EC287 are likely inhabitants for 286 laptops. The AMD chips require no minimum on their clock speeds, and since power consumption is tied to clock speed, a clever, energy-conscious design can result in an even lower average power usage. The 80EC287 is also fully static, so you can actually stop its clock, which drops the power draw down to about 5 mA.

Weitek

Weitek's FPUs operate exclusively on 386 and 486 systems. The Abacus 3167 and 4167 coprocessors are not Intel clones. Their internal structure is markedly different from that of the 80x87-series coprocessors, and they're not pin-compatible with the 80x87, so to use them your computer must have a Weitek socket. On the other hand, since the Abacus chips don't respond to 80x87 instructions, you can run both an 80387 and a 3167 in the same machine.

An x-ray view of Intel's FPUs reveals a set of eight 80-bit data registers. Although you can address the registers individually, you can also treat the entire set as an eight-element stack. The Abacus FPUs have no stack architecture, so you can only address each of the 31 registers individually. The registers also have a dual nature: Ordinarily, each is 32 bits wide; however, you can pair 30 of the registers (starting with number 2) into 15 64-bit megaregisters for double-precision mathematics.

The Abacus chips are also memory-mapped. As such, they don't look for Intel coprocessor instructions. Instead, the chips occupy a 64K-byte window in

80C287
80EC287

Company
Advanced Micro Devices, Inc.
901 Thompson Place
P.O. Box 3453
Sunnyvale, CA 94088
(408) 732-2400

Price
80C287-10: $99
80EC287-10: $109

Inquiry 1061.

80287XL
80387DX
i486

Company
Intel Corp.
1900 Prairie City Rd.
Mail Stop FM2-18
Folsom, CA 95630
(916) 351-2747

Price
80287XL-10: $370
80387DX-33: $994
i486-25: $722 each in quantities of 1000

Inquiry 1062.

physical memory (starting at address 0C0000000 hexadecimal). The Abacus chips decode locations within that window to trigger specific instructions. For example, writing into the memory address at offset 800h within the window causes the Abacus chips to execute a single-precision multiply instruction.

The advantage to using a memory-mapped architecture is speed. The conventional approach—taken by Intel and the Intel clone vendors—requires both instructions and data to pass to the coprocessor via the data bus. Furthermore, the FPU must decode coprocessor instructions coming down the data bus, which creates additional time overhead. The memory-mapped approach puts the instruction on the address lines. So, a single MOV instruction transfers the instruction *and* the data to the FPU.

One Abacus feature not highlighted in my tests is the coprocessors' matrix capabilities. While the coprocessor decodes addresses in its memory window to determine which operation to perform, the situation is actually more complex. The Abacus chips perform further decoding on the address lines to select source and target registers. And Weitek's designers have constructed the coprocessors so that those address lines that select the target registers fall on doubleword boundaries. The upshot of all this is that you can use fast REP STOSD and REP MOVSD instructions to do rapid vector operations. For example, I can quickly load the eight single-precision registers starting with register 1 using

```
LEA     ESI,ARRAYSTART
MOV     ECX,8
MOV     EDI,0C0000404H
REP     MOVSD
```

where I'm assuming the code is executing in the 386's "flat" addressing mode. Applications software that is aware of this feature should realize a performance gain beyond what the benchmark tests reveal.

IIT

IIT offers both 80287- and 80387-class chips. The 2C87 and 3C87 are CMOS parts; as an example of the reduced power requirements, the 3C87 uses 25 percent less current than an 80387. Both are fully hardware and software compatible with their Intel equivalents, although IIT claims both have better performance than Intel coprocessors. Both have low-power sleep modes that make them attractive to laptop designers.

But the IIT coprocessors aren't just faster and cooler (lower power consumption means less heat dissipation). Where Intel coprocessors possess a single set of eight floating-point registers, the IIT chips hold 32 registers, grouped into three banks of eight registers each. When you power up an IIT chip, its bank pointer sets to bank 0. The coprocessor recognizes four custom instructions that look like 80x87 instructions but aren't defined for the 80x87 instruction repertoire. Three of these custom instructions set the bank pointer to each of the three register banks. It's like having three chips in one, reducing the overhead of memory-to-FPU (and back) instructions.

Ordinarily, there's no cross talk between the register banks; the coprocessor is aware of only the currently active bank. The fourth custom instruction, F4X4, however, does operate on more than one bank. The F4X4 instruction multiplies two 4×4 matrices in a single instruction. (Matrix multiplication is common in 3-D graphics applications, such as CAD and animation software.) The elements of the matrices are spread throughout the register banks. The result—a four-element vector—lands in bank 0. This instruction reduces 16 multiplications and 12 additions (using classical matrix multiplication formulas) to a single instruction.

Cyrix

Cyrix makes only an 80387-class FPU. The differences between the Cyrix FastMath 83D87 and an Intel 80387 are subtle. The 83D87 uses CMOS circuitry for lower power consumption and automatically kicks into low-power mode when idle (the company claims that this reduces the chip's overall power draw to 5 percent of that of an 80387). The 83D87 is also faster than a standard 80387.

However, the engineers at Cyrix are proudest of the 83D87 processor's accuracy when calculating transcendental functions (i.e., exponentiation, logarithm, and trigonometric). The Intel coprocessors—and the AMD clones—perform transcendental operations using a variation of an algorithm known as the CORDIC routine. This algorithm is an approximation technique that—at least for the trigonometric functions—arrives at its solution via a series of angular rotations. Intel publishes the relative error bound for such approximations at the sixty-second bit position.

The Cyrix coprocessor evaluates transcendental functions using a polynomial approximation. Ordinarily, this would be prohibitively expensive in terms of execution time, since a polynomial evaluation requires a series of floating-point multiplications and additions, while the Intel FPUs' CORDIC algorithm uses only shifts and adds. However, the Cyrix chip's execution unit is built into the circuitry and is therefore much faster than the Intel chips' microcode sequencer. Simply put, where the Intel chips have to



FastMath 83D87

Company
Cyrix
P.O. Box 850118
Richardson, TX 75085
(800) 327-6284

Price
83D87-33: $994

Inquiry 1063.

2C87
3C87

Company
Integrated Information Technology, Inc.
2445 Mission College Blvd.
Santa Clara, CA 95054
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Price
2C87-10: $319
3C87-33: $779

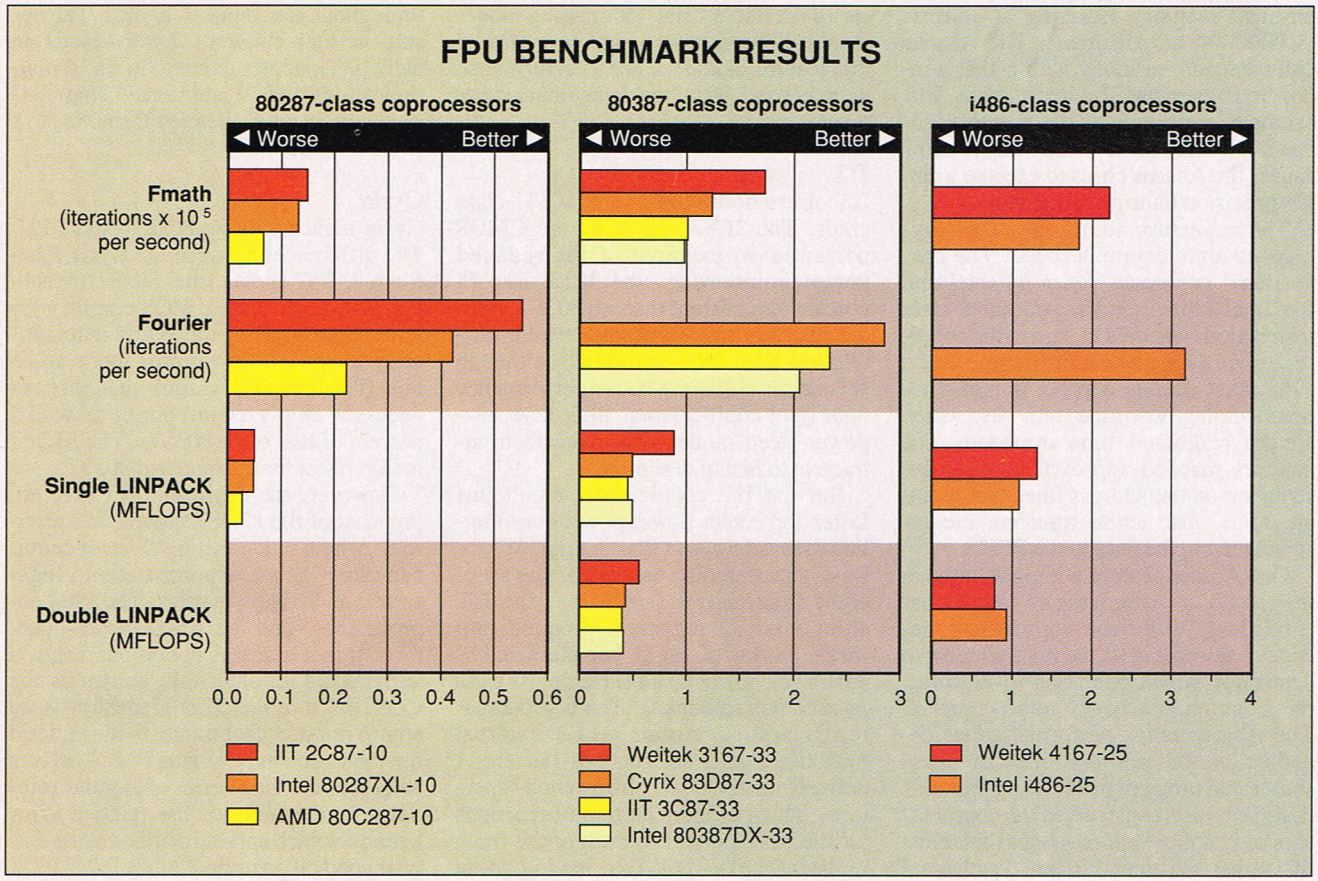
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Abacus 3167
Abacus 4167

Company
Weitek
1060 East Arqes Ave.
Sunnyvale, CA 94088
(800) 468-3167

Price
3167-33: $995
4167-25: $995

Inquiry 1065.



In the 80287-class category, the IIT 2C87 clearly outperformed both Intel's 80287XL and the AMD 80C287. Surprisingly, the 80C287, a CMOS chip, was slower than the 80287XL—the new CMOS version of Intel's 80287 FPU. Since the 80287 can't perform 32-bit moves, the double LINPACK test doesn't apply. The Abacus 3167 performed best overall in the 80387-class category, but it's not 80387-compatible, so your application has to support it. In the 80387-compatible category, Cyrix's FastMath 83D87 posted strong results across the board. The 3167 has no Fourier results because it doesn't directly support trigonometric functions (see the text for details). Weitek's Abacus 4167 outperformed Intel's i486 in the Fmath and single LINPACK tests but came up short on the double LINPACK. There are no Fourier results for the 4167 because it doesn't directly support trigonometric functions (see the text for details).

run itty-bitty programs to perform multiplications, the Cyrix chip does the multiplication in hardware.

The advantage of polynomial approximation is that it keeps errors below the sixty-fifth bit. IIT also uses polynomial approximation and a hardware multiplier but claims an upper error bound in only the sixty-second bit. An error difference between the sixty-second and sixty-fifth bit (2^{62} and 2^{65}) may seem minor, and for most business applications—which carry, at best, 53 bits of precision—it certainly is. If you're heavily into scientific or engineering number crunching, however, you may want to consider the Cyrix chip.

Cyrix also provided me with an early version of its new EMC87 coprocessor, which is best described as an Intel/Weitek hybrid. (Since this chip was a prototype, I didn't include the test results in the figure.) The EMC87 has all the internals of the 83D87, so you get the benefit of Intel compatibility plus the Cyrix speed and accuracy. But, as with the Abacus chips, you can also access the EMC87 in memory-mapped mode. I ran a preliminary test on the EMC87 in both Intel-compatible mode and memory-mapped mode and saw a performance increase on the order of 20 percent.

The Gauntlet

I used three machines as my testing arsenal. For the 80287-class coprocessors, I used a 10-MHz Microserve AT clone. A Club American Hawk 33-MHz 386 system served as my test machine for the 80387-class coprocessors. Finally, I used a Compaq Deskpro 486/25 for generating the i486 and Weitek 4167 tests. If you have a 25-MHz 386 system or an 8-MHz 286 system, don't despair; vendors offer their FPUs in several speeds, and the relative performance numbers should be the same within each processor class.

Testing math coprocessors is messy work, for several reasons. It requires wading into DOS extenders and 32-bit programming. I lived in constant fear that a statically charged and misplaced finger would bring testing to a halt. And I quickly discovered that coprocessor sockets aren't designed to let you take chips back out. This is especially true of the monstrous grid-array sockets that hold the 80387 clones and the Weitek chips. The expression "like pulling teeth" is all too appropriate.

I ran two different groups of benchmarks. First, I ran the FPU components of BYTE's low-level benchmarks on those coprocessors that would readily accept them (see "BYTE's New Benchmarks: New Looks, New Numbers,"

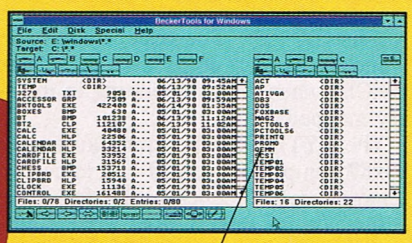
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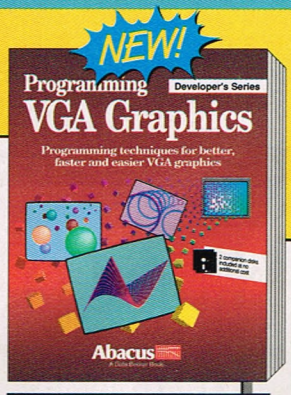
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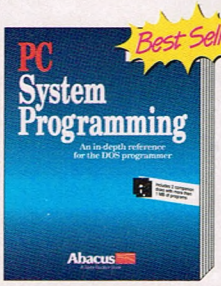
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August BYTE). The exceptions were Weitek's Abacus chips and the Cyrix EMC87 when it was operating in memory-mapped mode.

The BYTE FPU benchmarks expect 80x87 compatibility, so I had to craft a separate set of benchmarks for these chips. To do this, I used Phar Lap's 386|ASM assembler and Run386 DOS extender, accompanied by some assembly language macros from Weitek. When you execute Run386, it senses the presence of an Abacus chip and creates a selector that you can use to address the coprocessor. Using Weitek's macros, I easily constructed an Abacus equivalent of the Fmath benchmark. I didn't build a version of the Fourier benchmark for the Abacus chips, because they don't directly support trigonometric functions.

If you need transcendental functions, Weitek provides a software library that it claims is faster than on-chip operations. The Cyrix EMC87 appears in the same memory-mapped region as the Abacus chips, and I discovered that you can force Run386 to build the selector as though an Abacus chip were present. So, a few modifications to the Abacus benchmark yielded an EMC87 version of Fmath.

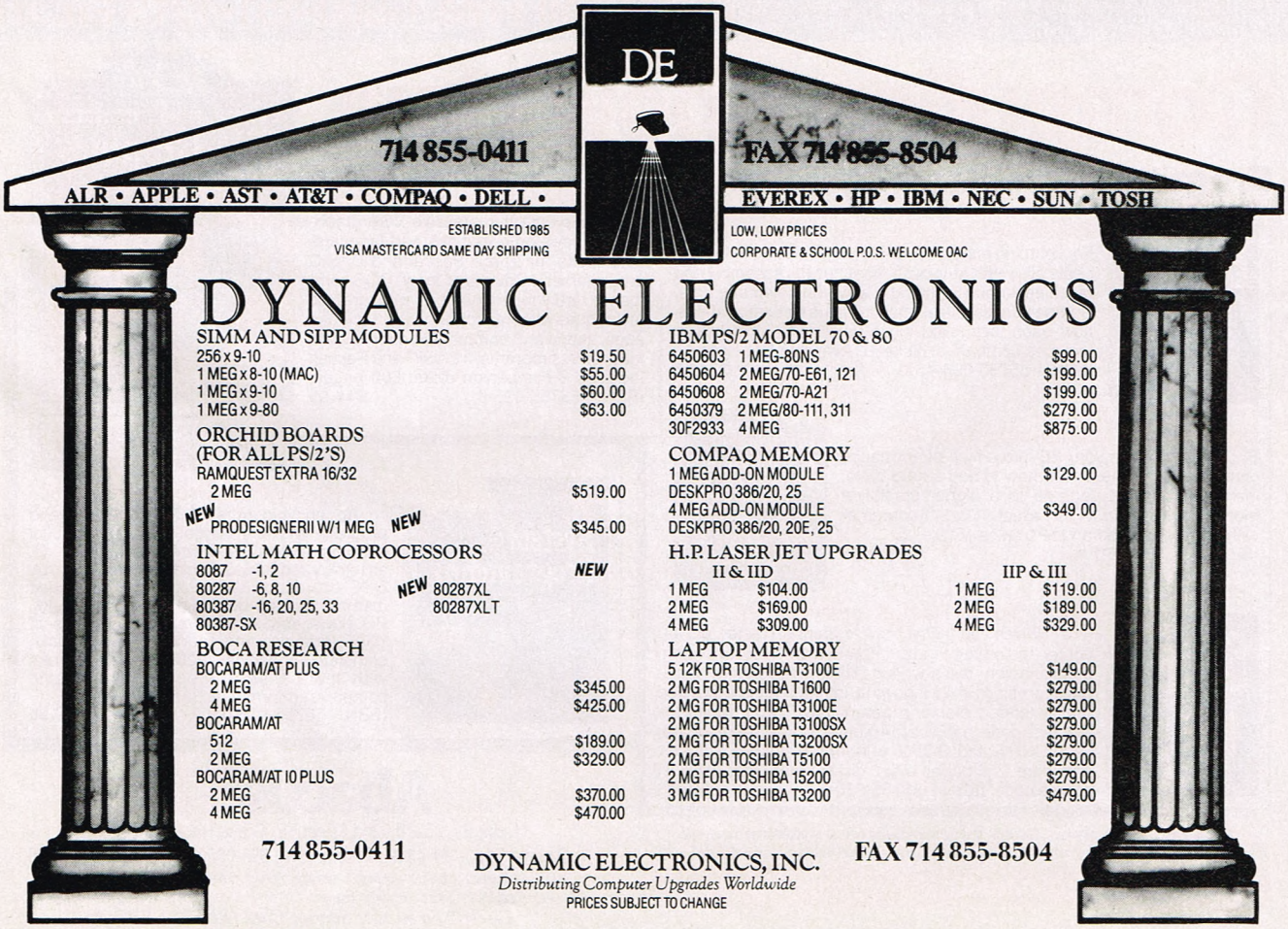
The FPU benchmarks produced some clear leaders in each category.

I also ran the LINPACK, a popular floating-point benchmark written in FORTRAN. I chose Lahey F77L FORTRAN as the compiler, since it is available in a 32-bit version bundled with Eclipse Systems' OS/386 DOS extender. I ran both single-precision and, for the 386 and 486 systems, double-precision versions of the LINPACK. The double-precision LINPACK is so large that it can only run in 32-bit mode. Hence, I could run only the single-precision version on the 286 machines. The results of all the tests are shown in the figure.

If your applications consist primarily of spreadsheets and bookkeeping calculations, the Fmath results should give you a good picture of the chips' rankings. Fmath tests the fundamental operations: addition, subtraction, multiplication, and division. If your work involves scientific or engineering calculations, or if you're a 3-D CAD user, the Fourier test is a good indicator of coprocessor performance in the more esoteric areas of transcendental calculations. The results of the LINPACK test provide an overall measurement of the coprocessors' floating-point throughput.

FPU Finalists

The FPU benchmarks produced some clear leaders in each category. Weitek's Abacus 4167 proved an able companion for the Deskpro 486/25, outperforming the i486's integrated FPU on all but the double LINPACK test. One possible explanation: The 4167 must perform two doubleword moves to load its chip registers with double-precision values. By contrast, the i486 requires only a single instruction. With a list price of $995, the Abacus 4167 isn't cheap, but it's your only choice if you need to enhance your 486's math performance.



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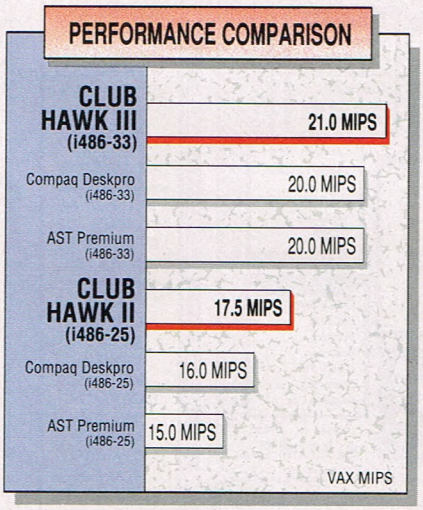
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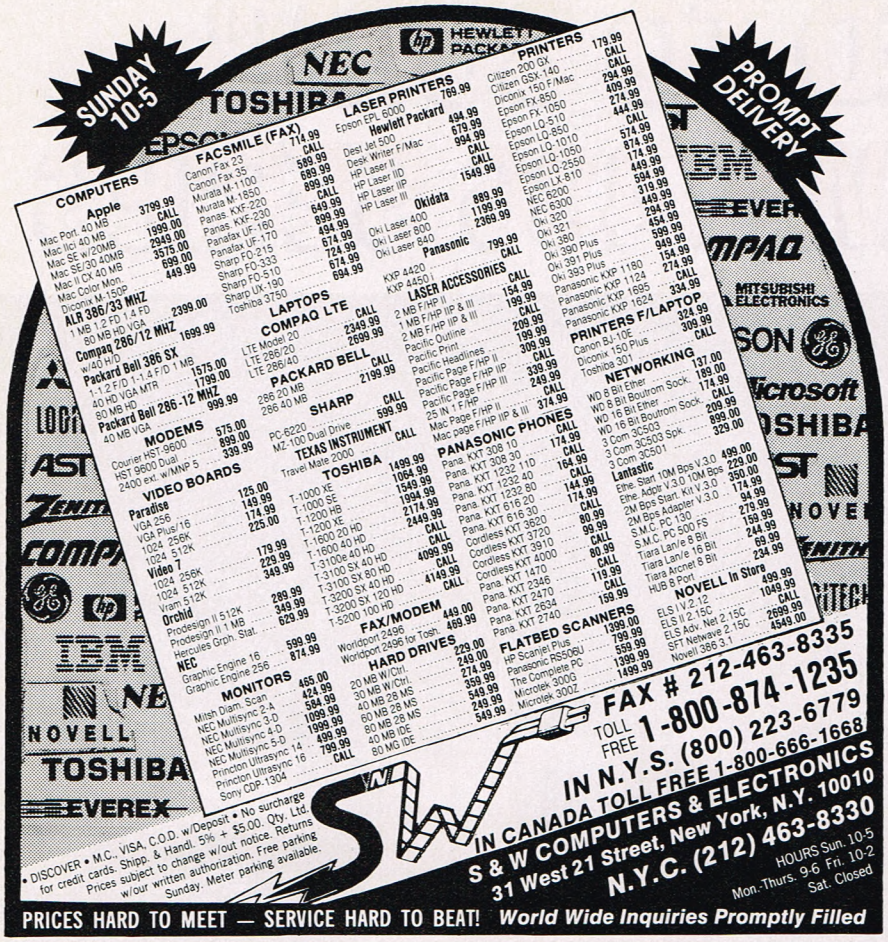
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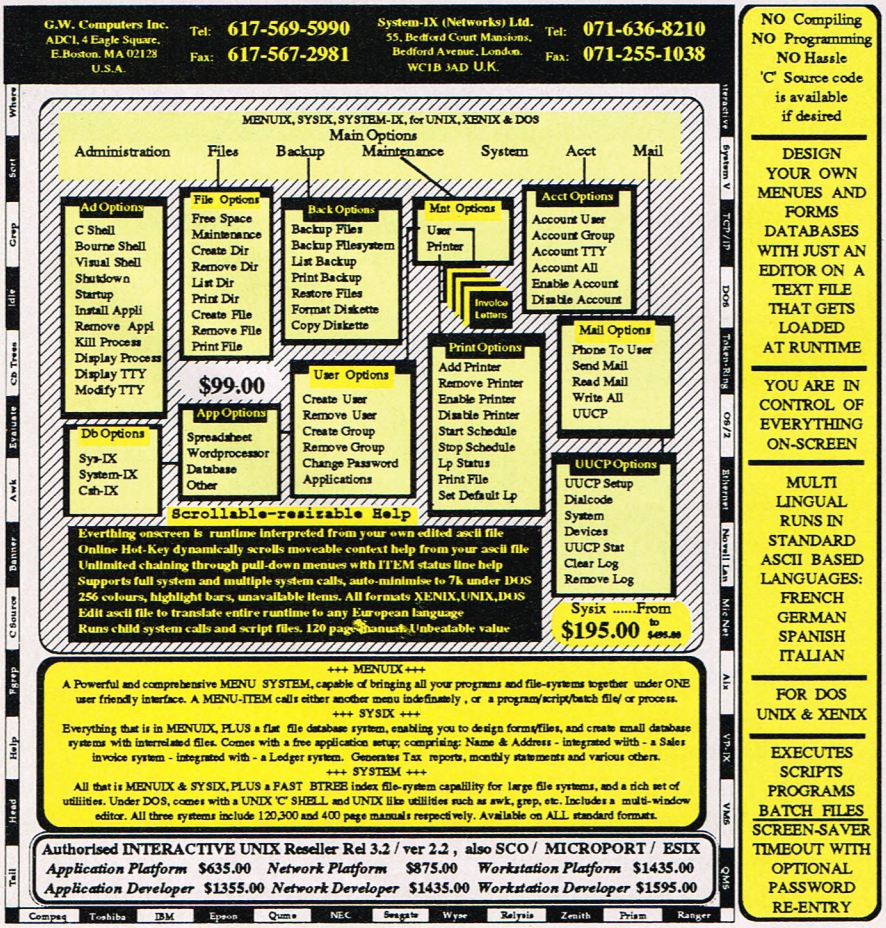
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REVIEW

FPU Face-Off

In the 386/80387 category, Weitek again came out on top with its Abacus 3167. At $995, this is also the most expensive chip in this category. To use this chip, your machine must have a Weitek FPU socket, and the applications software you're running must support the 3167. (Weitek provides a list of software packages that are compatible with the Abacus coprocessors.)

Also, if accuracy is critical, keep in mind that the Weitek chips can only handle single- and double-precision floating-point numbers. They don't support the IEEE 80-bit extended-precision numbers that some scientific and engineering applications might require. This is not a problem for the majority of applications, however.

If the Abacus 3167 doesn't fit your needs, the next logical choice is Cyrix's $994 83D87. If 3-D transformations are all the floating-point work you ever do, and your software supports IIT's custom instructions, the 3C87 may be a contender. But the 83D87 is faster than anything other than the Abacus 3167, is Intel compatible, and is priced on a par with Intel's 80387DX. Tack the 38D87's improved transcendental accuracy on top of that, and you've got a winner.

You may also want to check out the Cyrix EMC87, which should be available by the time you read this. It's got all the advantages of the 83D87, plus a memory-mapped architecture. If the final version performs as well as the 83D87, it will give the Abacus 3167 a run for its money.

In the 80287 arena, most manufacturers are aggressively pricing their coprocessors, and AMD leads the way with its $99 80C287. Note, however, that price is just about the only thing that the AMD coprocessors have going for them; the 80C287 won't set any speed records. Best performance is a toss-up between IIT's 2C87 ($319) and Intel's 80287XL ($370). The 2C87 is slightly faster and less expensive, but the 80287XL enjoys the extra 80387-type instructions. No applications yet support IIT's custom instructions or the 80287XL's 80387 instructions. But developers are likely to support the Intel chip first.

My benchmark results are a good guide to performance. But as with most computer peripherals, the best benchmark is to grab your critical software, find a computer store that sells coprocessors, and go for a test drive. ■

Rick Grehan is the director of the BYTE Lab. He can be contacted on BIX as "rick_g."

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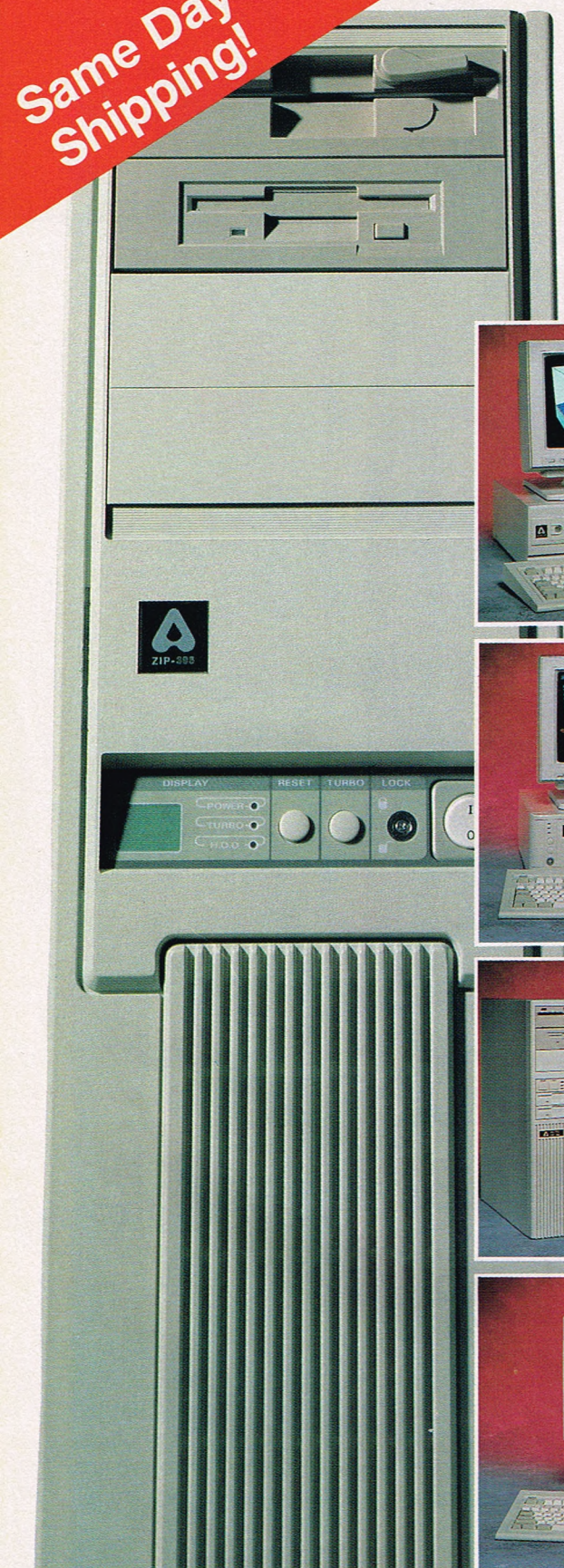
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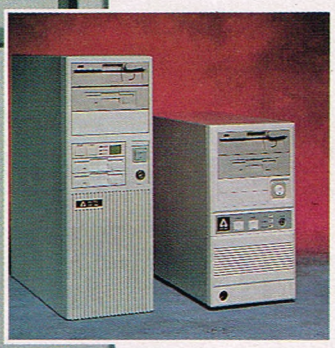
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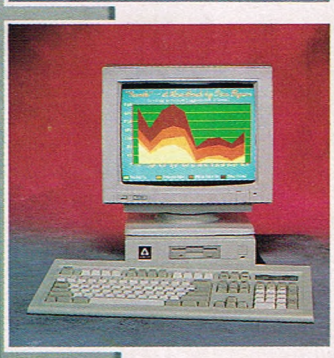
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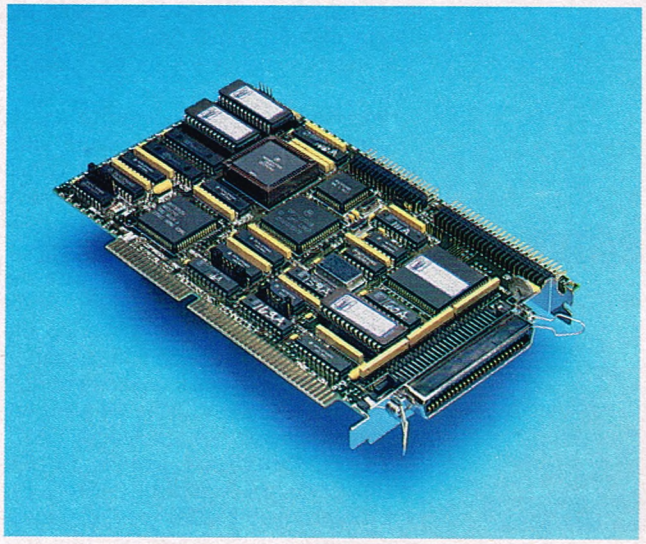
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Without floppy disk drive controller: $330

Inquiry 1105.

If you're accustomed to conventional PC interfaces, SCSI is a strange breed. Neither the original PC architecture nor the current version of DOS was designed for SCSI devices. So, before your PC can capitalize on SCSI's speed and flexibility, you may find yourself mixing and matching specialized software drivers, hard disk drive controllers, hard disk drives, and motherboard ROMs.

Distributed Processing Technology's SmartConnex/ISA SCSI controller can bridge this gap between IBM ATs and SCSI (DPT also announced a SmartConnex for Extended Industry Standard Architecture that wasn't shipping commercially in time for this review). The 16-bit SmartConnex/ISA uses the Western Digital WD1003 disk drive controller interface, which makes your computer see the controller as a common ST506 AT-compatible device without your having to install special driver software. The SmartConnex also works with your other drive interfaces. An associate and I installed it and an external hard disk drive in a 386SX with an internal hard disk drive that used a motherboard-based Intelligent Drive Electronics interface, and both drives worked fine.

The SmartConnex also includes internal and external interface connectors, so you can attach SCSI hard disk drives either through a rear panel or from inside the computer. And because the board uses a 10-MHz 68000 CPU, it can outperform some SCSI controllers in read- and write-throughput speed.

However, problems with the board's design and documentation mean that SCSI installation still isn't headache-free. Nevertheless, if you're a PC user who's interested in adding a SCSI-based high-capacity hard disk drive, the SmartConnex is worth considering.

Why SCSI?

SCSI's advantages center on speed and flexibility (see "The SCSI Bus," Parts 1 and 2, February and March BYTE). SCSI's speed is due to the fact that it is a parallel interface, not a serial interface like the ST506. SCSI is flexible because it was designed to be more than just a hard disk drive interface. More and more devices—including tape drives—are showing up with SCSI compatibility. And while the serial ST506 limits you to two physical disk drives, SCSI supports up to eight devices—seven peripherals and a controller board.

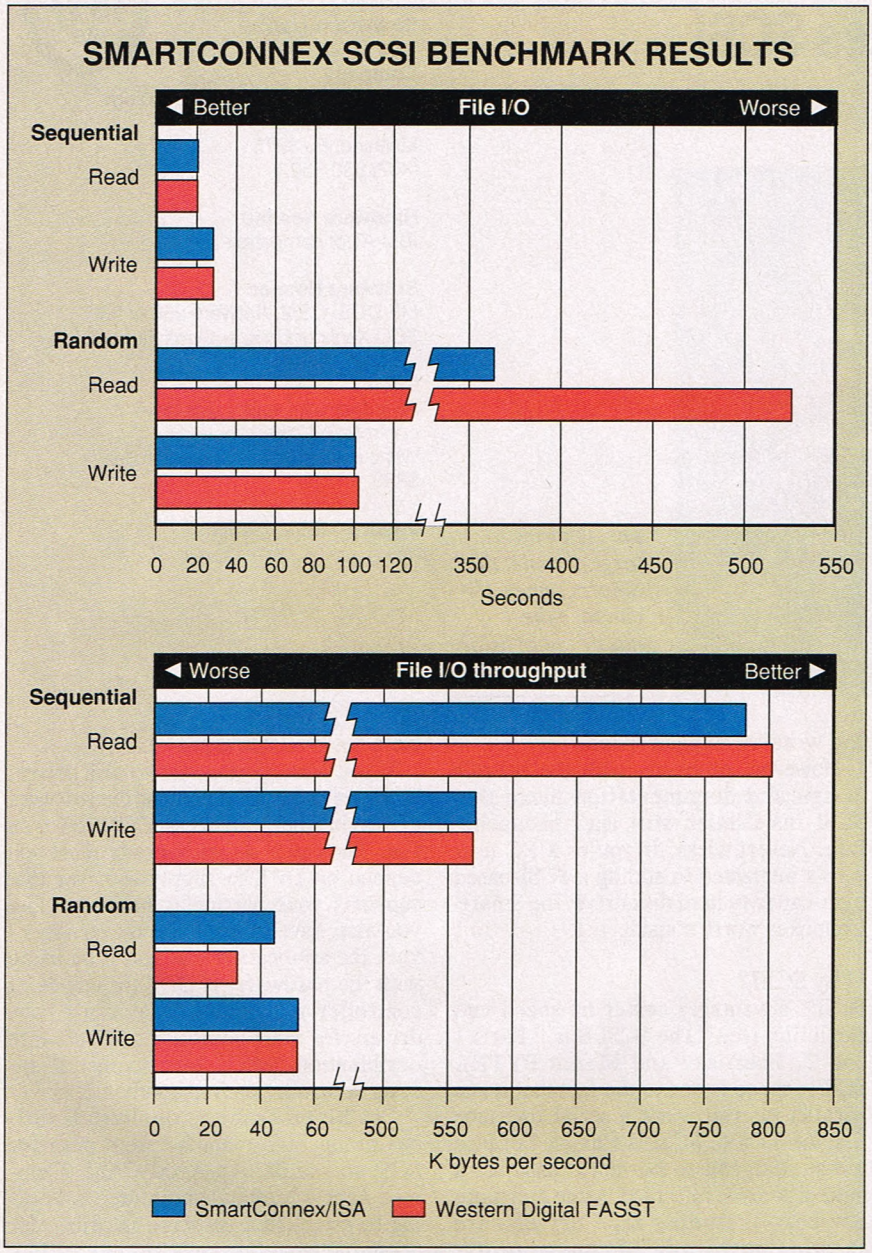
The major problem for PC users is that MS-DOS doesn't include a generic interface that supports all the devices available with a SCSI connection. That means that when you install a SCSI connection, you usually must also install a software driver that is compatible with both the device you are controlling and the applications you want run. This is still true with the SmartConnex for everything except a hard disk drive, although DPT says that it is developing device drivers for tape and optical disk drives (release dates were not available at press time).

If you want more than two disk drives, you have to install a compatible software driver in your MS-DOS CONFIG.SYS file. The catch is that not only must you depend on DPT to supply a driver that supports your particular hardware, but you also have to hope the driver works with the application that you'll be using with the hardware. If DPT (or any SCSI controller manufacturer) doesn't have drivers for your hardware and software combination, you'll have to install another controller or find another device.

But this problem may diminish as various groups and manufacturers push for SCSI standards. An ANSI CAM (Common Access Method) committee is working to establish a software interface for SCSI that would be installed in a variety of operating systems. If such an interface is successful, hardware vendors would only have to write their interfaces to the common software standard instead of to every operating system and application.

Tight Squeeze

In addition to having a SCSI connection, the SmartConnex can include an optional floppy disk drive interface that is compatible with 5¼- and 3½-inch devices. The SmartConnex's ST506 compatibility is built in, which means that you can plug the board into the PC bus, hook up the floppy and hard disk drive cables from your standard drives, and go. Actually, a software driver stored on the disk



Although the SmartConnex/ISA can simplify upgrading to SCSI, its performance was only marginally better than that of the Western Digital controller that shipped with the test 300-MB SCSI hard disk drive.

and transparent to the user handles ST-506 emulation. A DPT utility controls driver installation and use.

But installing the board can present problems. First of all, it's 4½ inches high, not including the bus connect pins. That was too tall to fit into our CompuAdd 316s slim-line test machine. The internal connectors and the top of the board stuck out beyond the edge of the chassis (we installed the board in this box, and it worked fine with the cover off).

The board also was too tall when we used the internal interface connectors in our private-label 20-MHz 386 clone with a full-size AT case. If no cables are attached to the internal connectors, the case fits—but just barely. However, with this particular clone, we could not attach the external connector because of the width of the slots in the rear of the case. SCSI uses a large 50-pin, D-shell connector, which requires the maximum slot width. For comfortable use, you'll need an oversize AT-type case for this board.

Yet another problem occurred when we tried to use the board in an Austin 12-MHz 286 and a CompuAdd 216—small-footprint PCs with internal bus risers that accept boards sideways. In these machines, the cables that connected the SmartConnex to the floppy disk drive were too short. We had to disable the floppy disk drive interface on the board and use the connectors on the motherboard.

We also found that the SmartConnex's documention and supporting utility software seemed unfinished. In fact, we had considerable difficulty getting the board up and running, because the instructions for using the utilities were not clear.

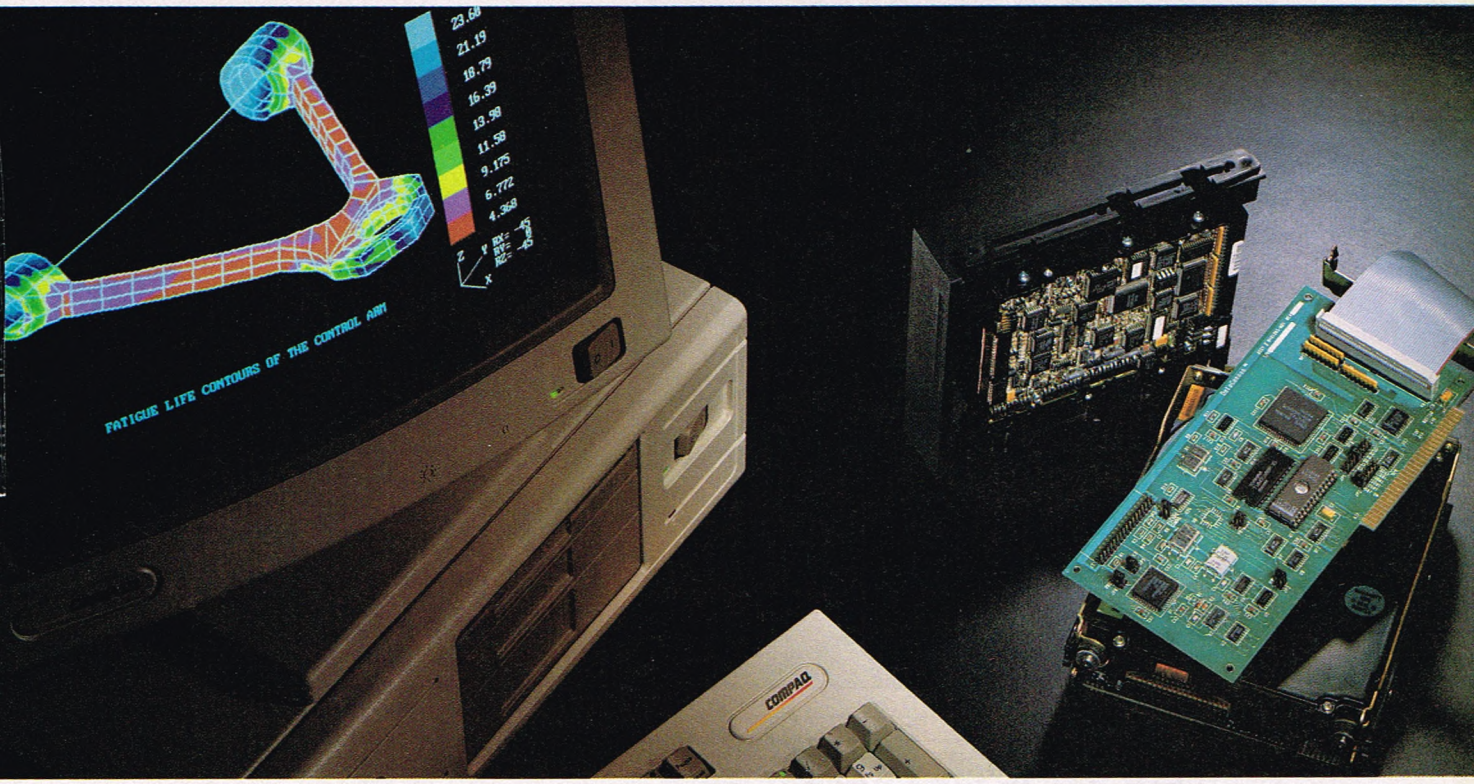
To install a hard disk drive with the SmartConnex, you run a simple utility that calls a low-level format routine and then stores the proper ST506 emulation driver on the last block of the hard disk drive. Drivers are available for a variety of operating systems, including OS/2, MS-DOS, Xenix/Unix, and Novell NetWare. Once you complete these steps, you simply type FDISK (or the equivalent, depending on your operating system), perform a high-level format, copy the system over, and load your files.

However, when we repeated this process during testing with a Core International Model 310 SCSI hard disk drive, we received numerous `drive not ready` and `no boot device` messages. Nothing in the documentation explains these errors. As it turns out, the emulation software that is stored in the final drive block cannot be erased, and the utility software is not smart enough to know what to do when it discovers that the driver software already exists. This was the source of our numerous error messages, according to DPT technical-support personnel. (DPT sent us a utility that will erase the driver software. The company doesn't ship the utility in the basic package on the theory that once you conduct a low-level format and install the driver, you don't need to remove it unless you change controllers.)

The documentation lacked a "quick start" section, forcing you to uncover installation instructions obscurely embedded in page after page of technical discussion. When we put aside the manual and anonymously called the company, technical support proved to be quite good. On one call, we received 20 minutes of support time without complaint.

Aside from poor on-screen instruction and incomplete documention, we liked the SmartConnex. Although DPT rates the SmartConnex's transfers at only 4 megabytes per second, we found that it operated relatively quickly. It rapidly

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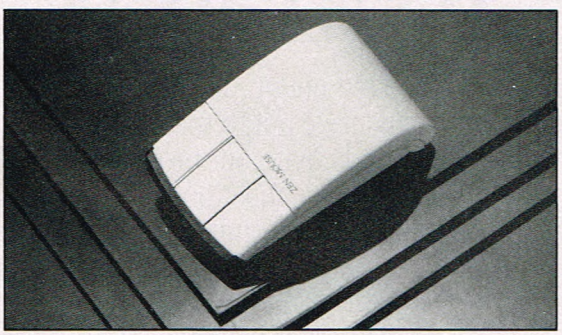
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REVIEW

Once you get past the installation difficulties, the SmartConnex performs as promised.

completed long menus and data-file searches. BYTE Lab benchmarks of the board with the Core hard disk drive showed random-read throughput of about 45K bytes per second; random-write throughput came in at around 54K bytes per second (see the figure). For comparison, we ran the same tests using the Western Digital FASST SCSI controller that ships with the drive. We found the Western Digital controller considerably slower on reads and nearly identical on writes: Random-read throughput was approximately 31K bytes per second; random-write throughput was more than 53K bytes per second.

Guarded Recommendation

Once you get past the installation difficulties, the SmartConnex performs as promised: It's somewhat faster than the interface that comes with the drive we tested, and the board's ST506 drive emulation makes for what should be an easy installation. We also liked the internal and external connections and the optional built-in floppy disk drive controller that lets you replace your existing controller, if that's what you need.

However, we are concerned that the board did not fit easily into four of our test machines, and the lack of easy-to-understand documentation and on-screen prompts made the installation much more difficult than it should be.

If you want to enhance your PC with SCSI, the SmartConnex can simplify the installation. Just make sure your computer's case is large enough to hold the board and that you have DPT's technical-support number in your telephone's autodialer. ■

Corey Sandler is president of Word Association, a consortium of high-technology writers and consultants headquartered in Nantucket, Massachusetts. He can be reached on BIX c/o "editors." He worked with Word Association technical editor Tom Badgett in testing the DPT board.

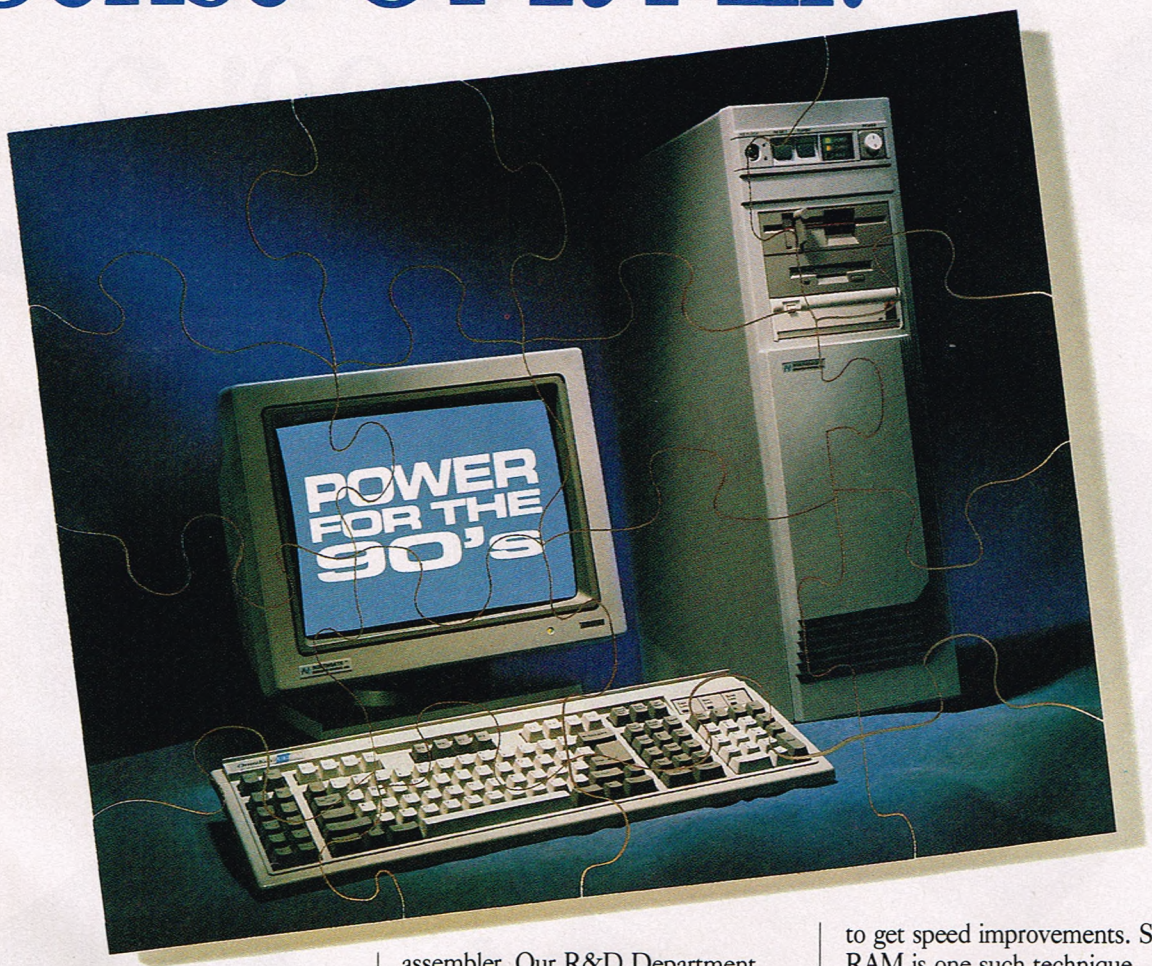
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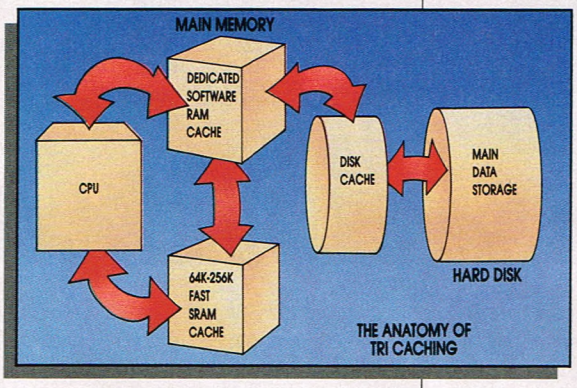
However, this RAM is best used for extended memory needs like disk caching, RAM disk, and spoolers. When Shadow RAM eats up this space, you can experience software compatibility and operating problems. You'll never experience shortcut-related problems with a Northgate system. Call toll-free **800-548-1993.**

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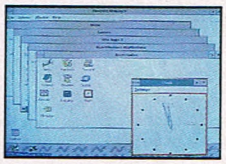
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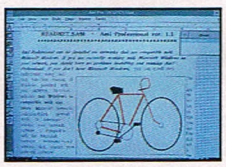
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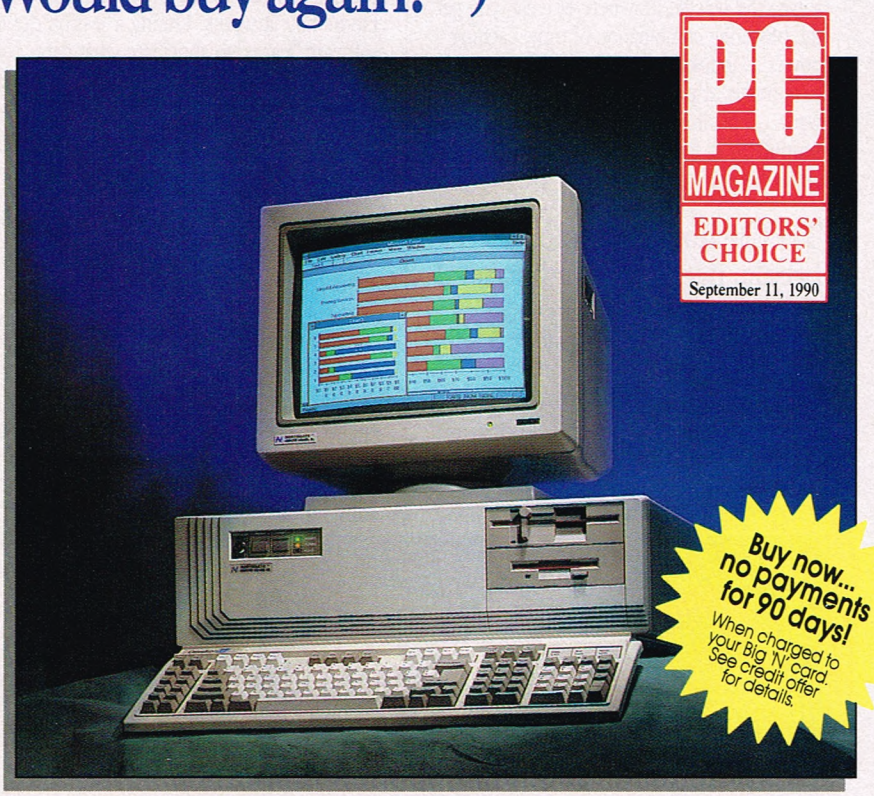
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* *PC Magazine*, September 11, 1990 ** *PC Magazine*, September 25, 1990
† *InfoWorld*, July 30, 1990 †† *Computer Currents*, August, 1990

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PC Magazine
October 31, 1989



Award winning 386 performance! Sizzling Northgate Elegance 386/33 and 386/25 systems both won *PC Magazine* Editor's Choice awards, been rated #1 and #2 products (respectively) in *InfoWorld* AND received *Computer Shopper* "Best Buy" recognitions. No other company can make that claim! Here's how we did it!

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- 64K SRAM memory cache; read/write-back caching
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- Eight expansion slots; one 32-bit slot; six 16-bit and one 8-bit slot
- Weitek math coprocessor support
- One parallel and two serial ports
- Hercules compatible video adapter
- Clock/calendar chip rated at 5 years
- 200 watt power supply (220 watt power supply in tower case)
- Optional seven bay upright Tower case; room for three exposed and four internal half-height devices or desktop case with room for three exposed and 2 internal half-height devices
- Front mounted reset and high/low speed controls
- Exclusive Northgate *OmniKey*/ULTRA keyboard
- 14" high resolution monochrome monitor
- MS-DOS 4.01 and GW-BASIC software installed
- On-line User's Guide to the system and MS-DOS 4.01
- QA Plus Diagnostic and Utility software
- 1 year warranty on system parts and labor; 5 years on keyboard
- FCC Class B Certified

Industry's finest 24-hour toll-free technical support! Your Elegance 386 is backed by expert technical support any time you need it. Call toll-free, 7 days a week, 24 hours a day. PLUS, free on-site next day service to most locations if we can't solve your problems over the phone.

Elegance 386 is backed by a one year warranty on parts and labor; five years on the *OmniKey* keyboard. If a part fails, we'll ship a replacement to you overnight at our expense — before you return your part!

Use Elegance 386 25 or 33MHz RISK FREE for 30 days! If it fails to meet your expectations, return it. No questions asked.

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$2999.00

Power User's System $4699.00

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Power User's System $5199.00

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SlimLine™ 386/25™



First time ever! Now you can have Northgate Elegance™ power, speed and performance in our popular space-saving SlimLine case! Elegance 386 computers shocked the industry with a #1 and #2 sweep of *Infoworld's* 1989 best product awards; AND three Editors' Choice awards from *PC Magazine.*

Cache! Cache! Cache! Like our powerful Elegance systems, SlimLine 386 features 64K SRAM cache to zip through the execution of instructions. For even faster speed, we've added a hard drive cache to make quick work of I/O transactions. To top it off, SlimLine 386 comes with Smartdrive DOS disk caching software that anticipates the information you'll need next and brings it into the cache for fast access.

Better features across the board! SlimLine's motherboard is highly integrated, allowing maximum system features in the smallest possible space. It includes space for up to 8Mb of 32-bit RAM, one parallel and two serial ports, fully integrated floppy disk controller and IDE hard drive controller. Plus an integrated SVGA with 512K Video RAM to speed up bus throughput — makes the system faster and more reliable! And there is still room for expansion with five open slots.

Three speeds! SlimLine 386 comes with your choice of 386DX 25 or 33MHz processors. For faster math-based applications — budgets, forecasts, spreadsheets and databases — all models feature 80387 coprocessor support to allow you to easily add floating point unit (FPU) performance.

33 Cache Systems!

All purpose systems! SlimLine Cache is the perfect network workstation or stand-alone unit for business and home use. It provides excellent support for advanced desktop publishing and graphics.

Base system includes 1Mb of RAM (expandable to 8Mb on the motherboard), a 40Mb fast access hard drive, 1.2Mb 5.25″ and 1.44 3.5″ floppy drives, a 12″ VGA monochrome monitor and our exclusive *OmniKey*®/PLUS keyboard.

You name it, we'll build it! Performance options include hard drives up to our super-fast 15ms 200Mb Maxtor hard drive, monitors and video display cards, math coprocessors, tape backups, printers and a host of other choices.

Or select our Power System with 4Mb of RAM, a 200Mb fast access hard drive, 1.2Mb 5.25″ and 1.44Mb 3.5″ floppies, a 14″ Super VGA color monitor and an *OmniKey* keyboard. Comes complete with Microsoft® Windows™ 3.0, Samna® Ami™ Professional word processing software, Informix® Wingz™ graphics spreadsheet and database software and a mouse to maximize system performance. This $1139.00 suggested retail value software is yours at NO EXTRA CHARGE!

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Slimline 386 Base System Features:

- 25 or 33MHz Intel® 80386DX processor
- 1Mb of 32-bit DRAM (expandable to 8Mb on motherboard)
- Down-scaled, proprietary, U.S.-made motherboard
- 40Mb fast access hard drive; AT bus interface; 1:1 interleave; 32K or 64K look ahead disk caching
- 64K SRAM memory cache; read/write-back caching
- High density 1.2Mb 5.25″ and 1.44Mb 3.5″ floppy drives; also read/write low density disks
- Five open expansion slots; three full length 16-bit and 2 half length 8-bit
- 25 or 33MHz 80387 or Weitek coprocessor support
- One parallel and two serial ports
- Built-in 16-bit SVGA with up to 1024 x 768 resolution; 512K video memory
- Clock/calendar chip rated at 5 years
- 100 watt power supply
- Small footprint SlimLine case with room for two exposed and 1 internal half-height devices
- Front mounted reset and high/low speed controls
- Exclusive Northgate *OmniKey/PLUS* keyboard
- 12″ VGA monochrome monitor
- MS-DOS 4.01 and GW-BASIC software installed
- On-line User's Guide to the system and MS-DOS 4.01
- QA Plus diagnostic and utility software
- Smartdrive caching software
- 1 year warranty on system parts and labor; 5 years on keyboard
- FCC Class B Certified

More great support! Your new SlimLine 386 Cache comes with a one year warranty on parts and labor; five years on the *OmniKey* keyboard. If a part fails, we'll ship a replacement to you overnight at our expense — before you return your part!

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Yes, we're a bit late to the party with SX systems. How come? We just couldn't bring ourselves to market another ho-hum SX.

So we put our research and development team on it. Boy, did they rise to the challenge! Now you can get an SX 16 or 20 MHz machine with the power to run Microsoft® Windows™ and other 32-bit software at flashing cache-enhanced speeds. And, they packaged all this power and performance into our exclusive space-saving case—a favorite of Northgate customers!

The secret to SlimLine's space-saving design? A fully integrated motherboard designed and manufactured by Northgate! This design reduces bus load—makes the system faster and more reliable!

Motherboard features include a built-in VGA adapter (with 512K Video RAM), parallel and two serial ports, fully integrated floppy disk controller and IDE hard drive controller. Motherboard integration also makes it easier to install modems or add-in cards.

Triple cache boosts performance to zero wait state! You get a built-in 64K memory SRAM cache to accelerate the execution of instructions; hard drive caching accelerates I/O transactions; and disk caching software speeds the movement of data to and from the CPU.

SlimLine™ 386SX™ 16 Or With 64K Cache!

SlimLine 386SX is perfect for office environments and home use. It handles word processing, spreadsheet, database management and most graphics applications with ease.

Slimline 386SX base system includes 1Mb of RAM (expandable to 8Mb) on the motherboard, a 40Mb fast access hard drive, 1.2Mb 5.25″ and 1.44Mb 3.5″ floppy drives, and a 12″ VGA monochrome monitor. Plus, you get Northgate's award-winning *OmniKey*®/102 keyboard.

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- 64K SRAM memory cache; read/write-back caching
- High density 1.2Mb 5.25″ and 1.44Mb 3.5″ floppy drives; also read/write low density disks
- Five open expansion slots; three full length 16-bit and two half length 8-bit
- 16 or 20MHz 80387SX or Weitek coprocessor support
- One parallel and two serial ports
- Built-in 16-bit SVGA with up to 1024 x 768 resolution; 512K video memory
- Clock/calendar chip rated at 5 years
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OPEN YOUR CREDIT CARD ACCOUNT BY FILLING OUT THE APPLICATION BELOW.

Please complete all appropriate sections, providing at least two years residence and employment history. If you are self-employed, please be sure to complete section d. **THIS IS NOT A CREDIT AGREEMENT!** One will be sent to you upon authorization of an account. (This Form Must Be Signed To Process Your Order.) All Financed Purchases Are Subject To Credit Approval. **If You Have Any Credit Questions, Please Call For Assistance.** Thank You!

A married person may apply for individual credit. I am applying for (check one box, please):
☐ JOINT CREDIT with another person. Complete entire application.
☐ INDIVIDUAL CREDIT complete only individual section.
☐ INDIVIDUAL CREDIT but rely on income of another. Complete entire application.
*If you are a married Wisconsin applicant, you must provide your spouse's information as indicated, even though your spouse may not be signing the contract.

NOTICE TO WISCONSIN APPLICANTS
You must disclose your marital status:
☐ married
☐ unmarried
☐ legally separated

a. Personal Information

NAME _____ HOME PHONE (____) _____
SOCIAL SECURITY NUMBER _____ DATE OF BIRTH ____ / ____ / ____
PRESENT ADDRESS _____ CITY _____ ST _____ ZIP _____
DATE OF RESIDENCE MO. _____ YR. _____ BUY ☐ RENT ☐ OTHER ☐ _____
PREVIOUS ADDRESS _____
EMPLOYER _____ DATE OF EMPLOYMENT MO. _____ YR. _____
MONTHLY GROSS SALARY $ _____ BUSINESS PHONE (____) _____
PREVIOUS EMPLOYER _____ DATES OF EMPLOYMENT _____ TO _____

Income from alimony, child support or separate maintenance payments need not be disclosed if you do not wish to have it considered as basis for repaying the obligation.

ADDITIONAL MONTHLY INCOME $ _____ SOURCE _____

b. Credit Information

PLEASE TELL US IF YOU HAVE: CHECKING ACCOUNT (Y/N) _____ SAVINGS ACCOUNT (Y/N) _____
BANK LOAN (Y/N) _____ HOW MANY? _____ VISA (Y/N) _____ HOW MANY? _____
MASTERCARD (Y/N) _____ HOW MANY? _____ FINANCE COMPANY LOAN (Y/N) _____ HOW MANY? _____
DEPT. STORE CHARGE CARD (Y/N) _____ HOW MANY? _____ CREDIT UNION ACCOUNT (Y/N) _____ HOW MANY? _____
OTHER MAJOR CHARGE CARDS (Y/N) _____ HOW MANY? _____

c. Joint Applicant's Personal Information

JOINT APPLICANT'S NAME _____ HOME PHONE (____) _____
SOCIAL SECURITY NUMBER _____ DATE OF BIRTH ____ / ____ / ____
ADDRESS _____ CITY _____ ST _____ ZIP _____
DATE OF RESIDENCE MO. _____ YR. _____
JOINT APPLICANT'S EMPLOYER _____ DATE OF EMPLOYMENT MO. _____ YR. _____
MONTHLY GROSS SALARY $ _____ BUSINESS PHONE (____) _____
NAME AND ADDRESS OF NEAREST RELATIVE NOT LIVING WITH YOU _____
_____ RELATIONSHIP _____

d. Self-Employment Information

BUSINESS NAME _____ BUSINESS PHONE (____) _____
TYPE OF BUSINESS ☐ Proprietorship ☐ Partnership ☐ Corporation IN BUSINESS SINCE _____
YOUR ANNUAL INCOME FROM BUSINESS Gross $ _____ Net $ _____
PERSONAL BANKER'S NAME _____ BANKER'S PHONE (____) _____

e. Customer Authorization

I authorize Northgate Computer Systems or its assignees to investigate credit records and to report my performance hereunder to credit agencies. I hereby certify that the following information is furnished to you for the purpose of obtaining credit and is true and correct of the best of my knowledge and belief. There are costs associated with the use of this credit card. To obtain more information about these costs, call us at 1-800-548-1993 or write to P.O. Box 59080, Minneapolis, MN 55459-0080.

NY—A consumer credit report may be requested in connection with this application or in connection with updates, renewals or extensions of any credit granted as a result of this application. If I subsequently ask for this information, I will be informed whether or not such a report was requested and, if so, the name and address of the agency that furnished the report.

OH—THE OHIO LAWS AGAINST DISCRIMINATION REQUIRE THAT ALL CREDITORS MAKE CREDIT EQUALLY AVAILABLE TO ALL CREDIT-WORTHY CUSTOMERS AND THAT CREDIT REPORTING AGENCIES MAINTAIN SEPARATE CREDIT HISTORIES ON EACH INDIVIDUAL UPON REQUEST. THE OHIO CIVIL RIGHTS COMMISSION ADMINISTERS COMPLIANCE WITH THIS LAW.

APPLICANT'S SIGNATURE _____ DATE _____

JOINT APPLICANT'S SIGNATURE _____ DATE _____

FOR MARRIED WISCONSIN APPLICANTS:
I acknowledge that the obligation described herein is being incurred in the interest of my marriage or family.

BUYER'S SIGNATURE _____ DATE _____

*You must request deferred billing when ordering. Payments will be deferred for three billing cycles after shipment. Interest will accrue during the deferred period at a rate of 1.5% per month (18% APR).
This is not an application. A completed application and agreement must be on file prior to approval for credit.

Circle 264 on Reader Service Card

Stanford Diehl

REVIEW

Windows Takes On WingZ

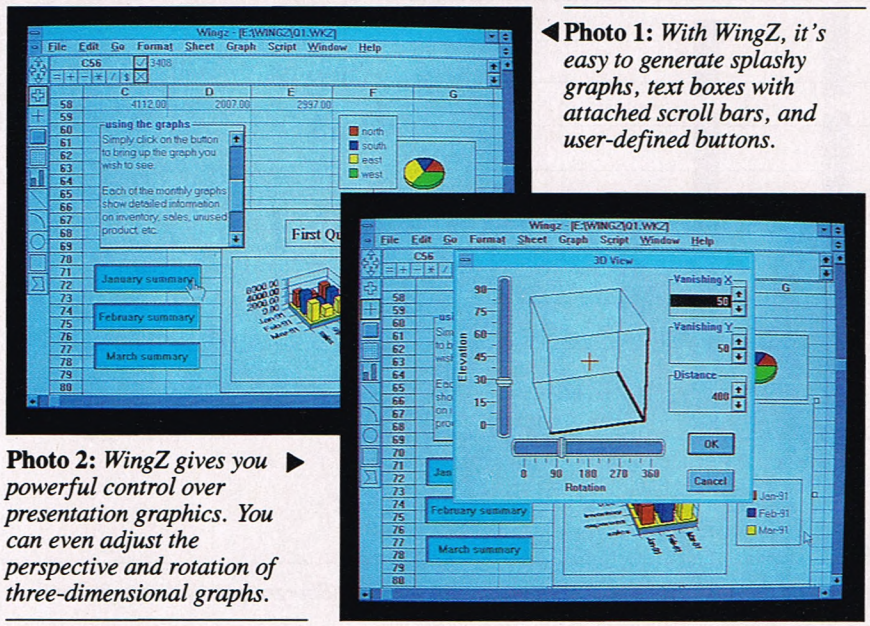


Photo 1: *With WingZ, it's easy to generate splashy graphs, text boxes with attached scroll bars, and user-defined buttons.*

Photo 2: *WingZ gives you powerful control over presentation graphics. You can even adjust the perspective and rotation of three-dimensional graphs.*

If there is a medium for gauging the graphical prowess of Windows 3.0, WingZ is it. One look at WingZ on the Macintosh proves just how graphical a spreadsheet can be. But can it do the same tricks on top of DOS? And, more important, is all this graphical wizardry more than an aesthetic diversion? Namely, will it make your spreadsheet chores easier or more effective?

The WingZ for Windows 3.0 comes bundled with an OS/2 version (the complete package is called WingZ PC).

WingZ PC

Company
Informix Software, Inc.
16011 College Blvd.
Lenexa, KS 66219
(913) 492-9922

Hardware Needed
2 MB of RAM (3 MB recommended); 2 MB of hard disk space; VGA, EGA, or 8514/A monitor

Software Needed
Microsoft Windows 3.0

Price
$499

Inquiry 1226.

When I began working with WingZ for Windows, I was immediately struck by its versatility and ease of use. Presentation features approach desktop publishing capabilities, and making graphs is downright *fun*. WingZ fits effortlessly into the Windows 3.0 environment, including support of Dynamic Data Exchange links and importing graphics metafiles. In the constrained arena of spreadsheets, WingZ apparently can leap through hoops of fire.

Once I got down to work, though, some annoying limitations sprouted up. WingZ spreadsheets are as big as you want them to be. You'd use up memory before you could use up those billion or so cells. You would think, given this potential mass of data, that you could easily change defaults and reformat an entire sheet. Not so. I selected an entire sheet by clicking on a box in the corner of the sheet. Easy enough. But when I made format changes with the whole sheet specified, WingZ balked. The changes would affect any data already entered in the sheet, but newly entered data would revert to the default format. You have to highlight a range and change formats manually each time (or write a macro to do it for you).

Taking Inventory

As a model, I set up three monthly inventory worksheets and a quarterly summary. The summary sheet used results from the three monthly sheets. I've found this type of operation easier to perform on a true three-dimensional spreadsheet such as Lotus 1-2-3 release 3.0. With true 3-D, all the sheets are combined into one structure resembling a cube. You can then "cut through" the cube to total the three monthly sheets. WingZ, on the other hand, uses external references to link the sheets. To reference a cell in an external sheet, you specify the filename and the cell reference (`external.ref:a1`).

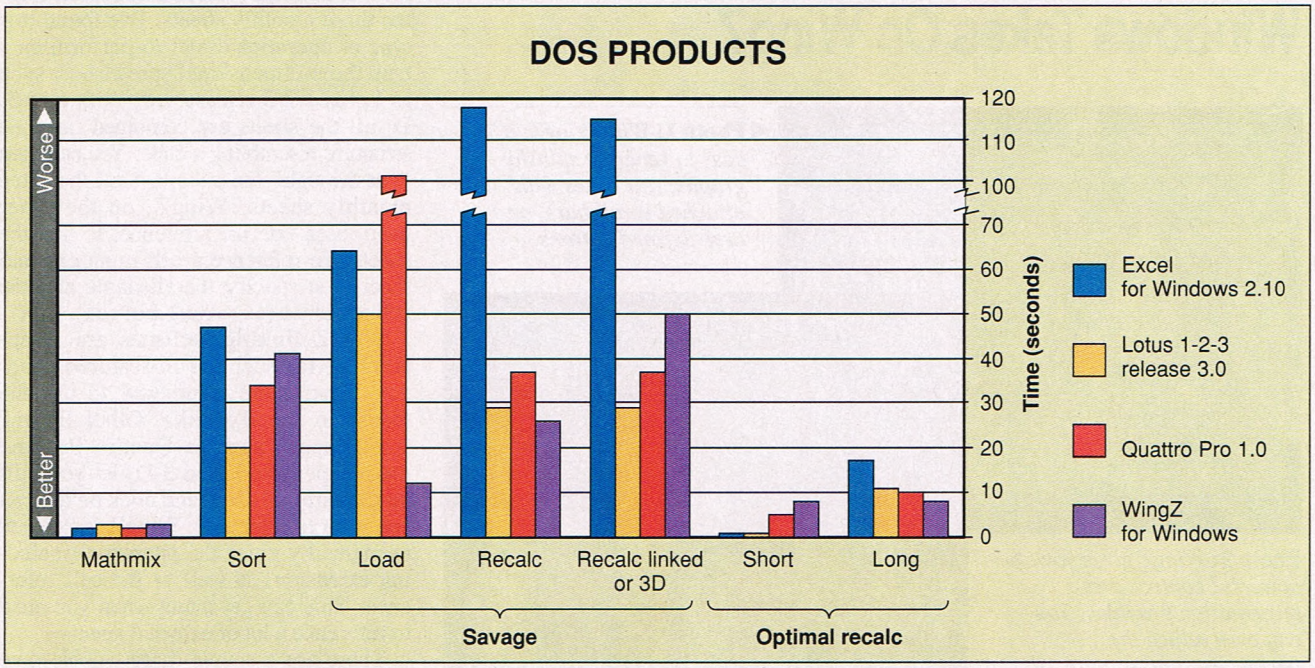
WingZ linking facilities are disappointing for such a full-featured product. First, there is no way to use the mouse to specify links. Other linking spreadsheets, such as Quattro Pro and the inexpensive Lucid 3-D, let you pull up the external sheet and click on the cell you want to reference. WingZ forces you to manually enter the filename (including extension) as well as the cell reference. This can get tiring when you need to reference a lot of external sheets.

There are a couple more troublesome limitations when you link sheets. You can't, for instance, link to a sheet on disk. All referenced sheets must be open. And WingZ does not automatically update the references. To negotiate the recalc benchmark for the linked Savage worksheets, I had to write a script that called each sheet and recalculated them one at a time.

Sometimes WingZ seemed surprisingly intuitive; other times, not at all. When I typed in "Feb 90," it understood that as a date and put the data in the default date format. Pretty smart. But when I added two cells together, both of them formatted as currency, it did not format the result as currency. Sometimes it even seemed to outsmart itself. When I added a blank column into the worksheet, WingA adjusted my external cell references. I then had to go back and change them so that they referred to the cells in my external sheets—cells that, of course, did not change location.

The Graphical Advantage

Start churning out graphs, though, and you may just forget all about WingZ's shortcomings. You just block off a range of data, click on the graph icon, and specify the area for the graph by simple click and drag. WingZ generates a graph on your sheet wherever you want it. There is a full grab bag of graphs to choose from, including scatter, contour, 3-D, and wire-frame graphs, to name a few. Once your graph has been created, you can resize it, move it, or revise it from the Graph menu.



WingZ performed admirably on our standard spreadsheet benchmarks. All times are in seconds. Shorter bars indicate faster execution.

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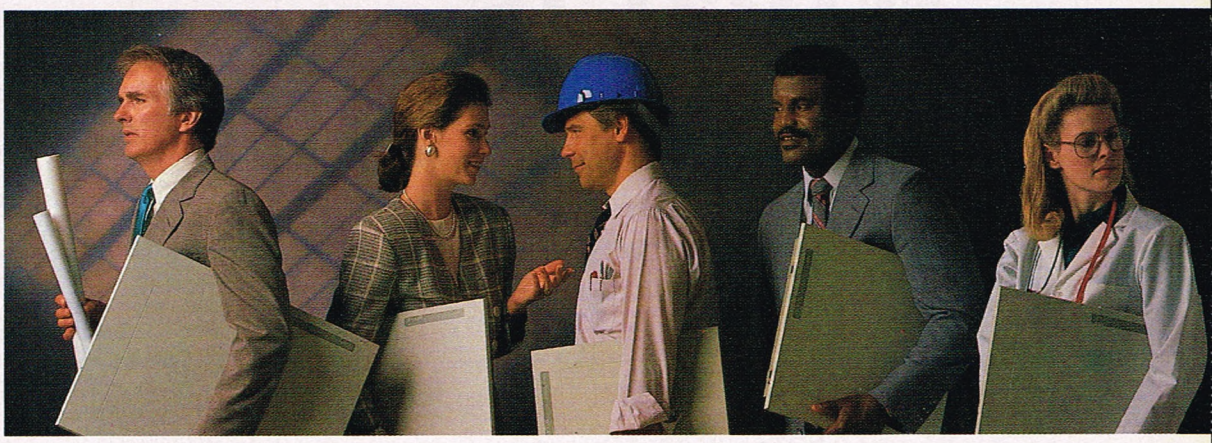
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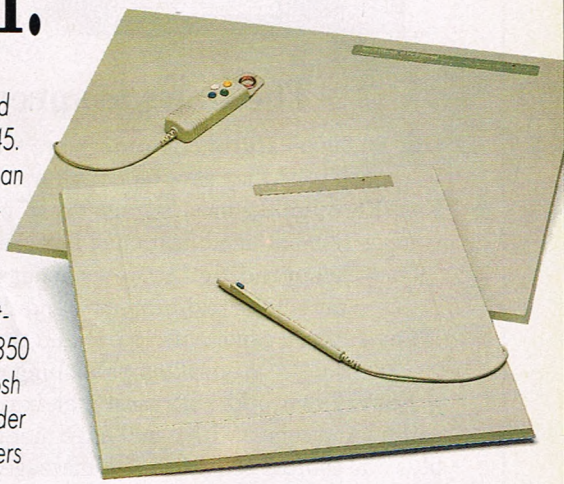
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The PC version includes interface cables for the IBM® PC, AT, PS/2 and compatibles. A utilities diskette with test and reset software, an Autodesk® Device Interface™ driver, Universal Mouse Emulator™ and a Microsoft® Windows driver. And an offer for a free tablet template (US and Canada only) worth over $245.

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SummaSketch II tablets have a standard accuracy measurement of ±0.015 inches, selectable resolution of up to 1,016 lines per inch and high proximity so you can trace from documents up to ½" thick. Add in convenience features such as a power/proximity light, on-off switch, wedge shape design for easy use, lightweight construction for portability—and it's easy to see why SummaSketch is the industry standard and the obvious choice of today's computer professionals.

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PC MAGAZINE EDITORS' CHOICE
November 28, 1989
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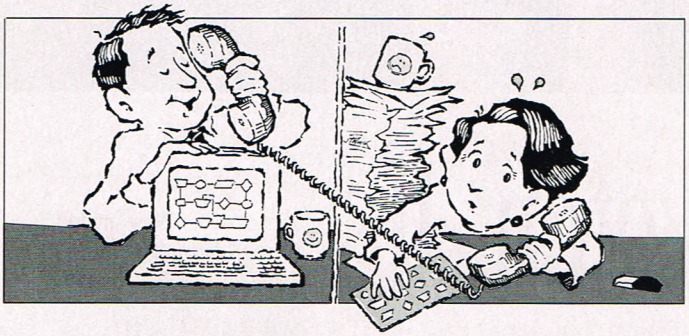
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As flexible as these graphs are, they, too, suffer from surprising limitations. You must first block off a contiguous range of data and generate a chart before you can manipulate it. If you want to add a new series outside the selected range, you must first copy an existing series, select the copy, and then specify the new series. It would be much easier if you had the option to specify all your ranges up front, before the graph is drawn. As long as your data lies in contiguous columns or rows, you are all right, but once you start jumping around, things get complicated.

In any case, the graphing functions are flexible enough for you to come up with just about any presentation that you could possibly want. You can even select different objects in the graph (the legend, the title, or the actual graph itself), separate them from the graph borders, and put them anywhere you want. I drew a graph, removed the legend, and placed it to the left of the row labels. I then placed the bars to the right of the data.

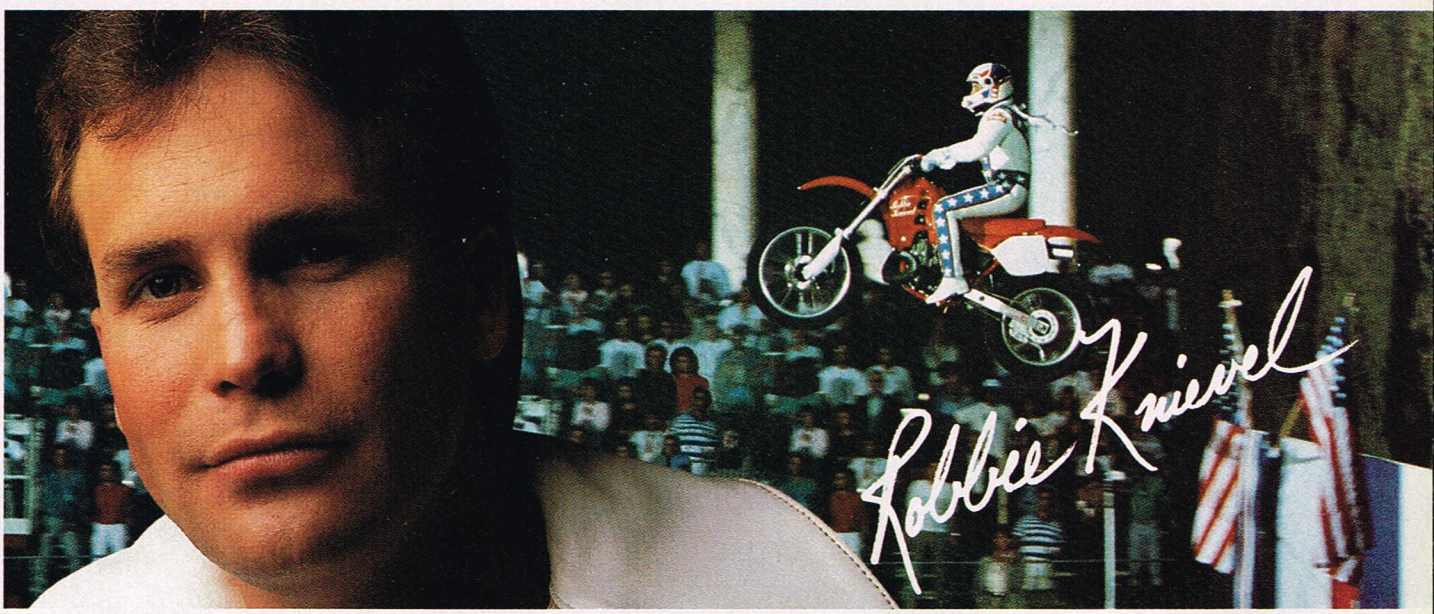
WingZ really shines when it comes to manipulating graphical objects like this. You can easily create "buttons" by clicking on an icon, and then attach scripts to them for truly automated spreadsheets. You could have sales data on your sheet along with a button that, when clicked on, would bring up another spreadsheet with a breakdown of sales by salespersons. You can draw ovals, rectangles, and polygons and fill them with a range of patterns or attach a drop shadow to them. Text fields are just as easy to create, and you can attach scroll bars to them. WingZ also boasts tabling, matrix, and database operations, as well as an impressive scripting language. A full set of functions is available, but if you can think up any functions it doesn't have, you can define them yourself using the scripting language.

In the end, WingZ is a mixed blessing. It can certainly put Windows through its paces, and for presentation punch, WingZ can't be beaten. The Windows 3.0 version is not quite as snappy as the Mac version, but it performs admirably when compared to other DOS (and even OS/2) products (see the figure). It falters somewhat when it's faced with the nitty-gritty work of filling in formulas, linking sheets, and simple formatting. If you can put up with a little more up-front work, WingZ can make your final presentations soar. ■

Stanford Diehl is a BYTE Lab testing editor/engineer and spreadsheet expert. He can be reached on BIX as "sdiehl."

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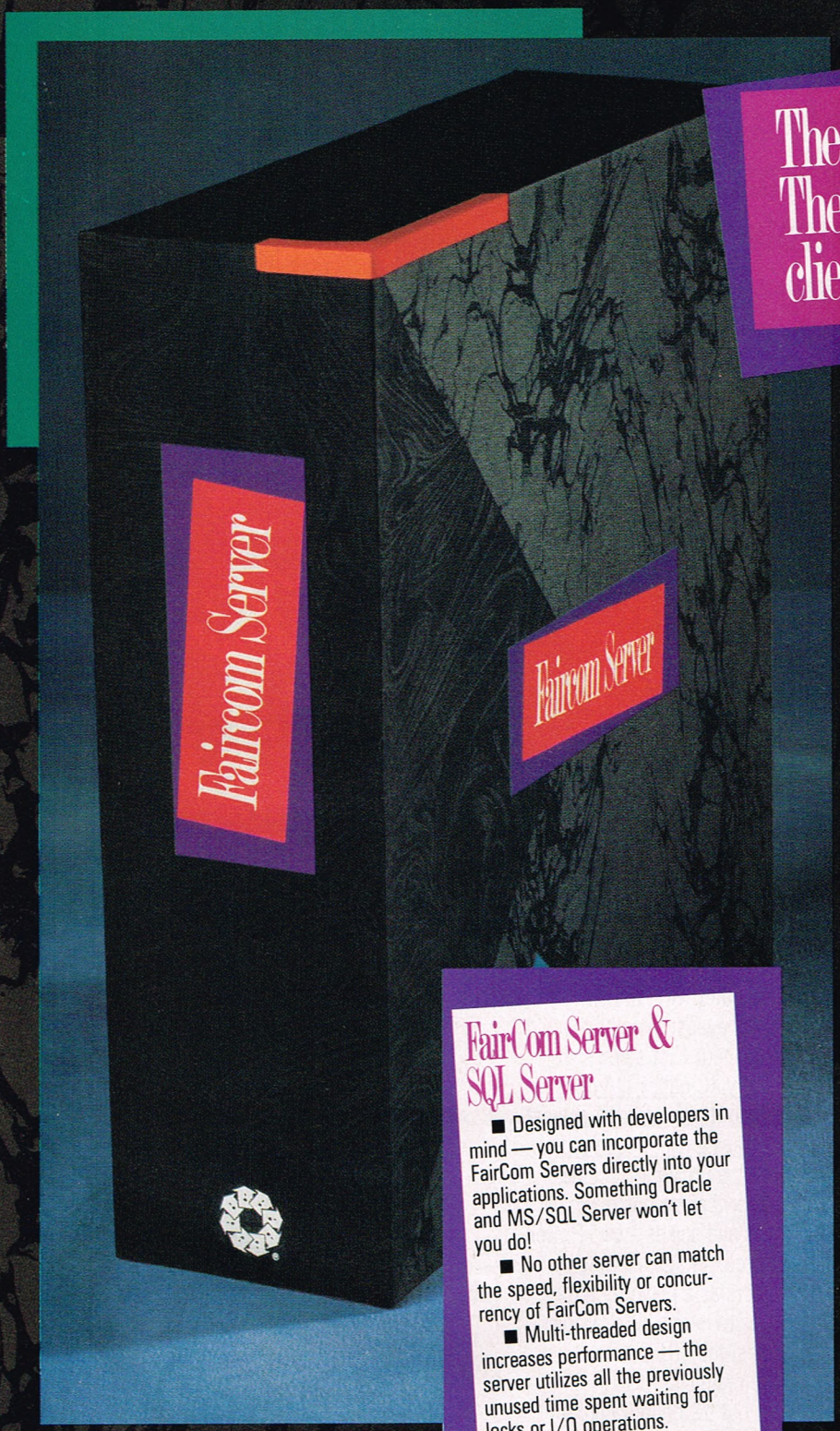
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Tom Yager

REVIEW

Mac-ish Interfaces for Unix

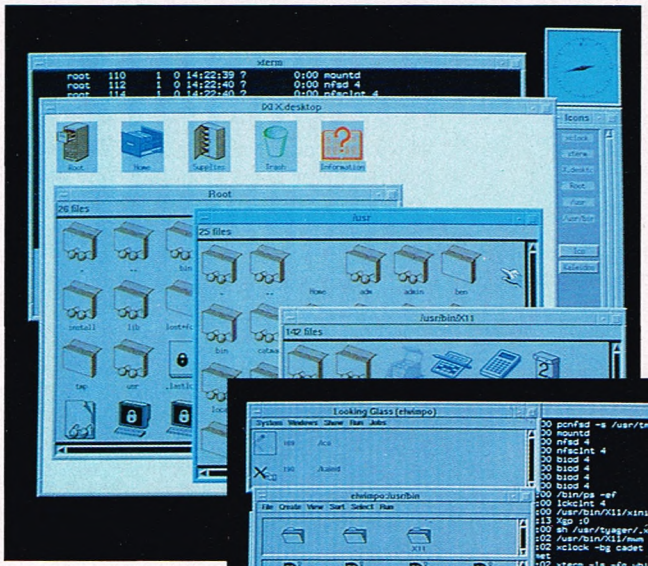


Photo 1: *X.desktop's main desktop window and iconic directory views.*

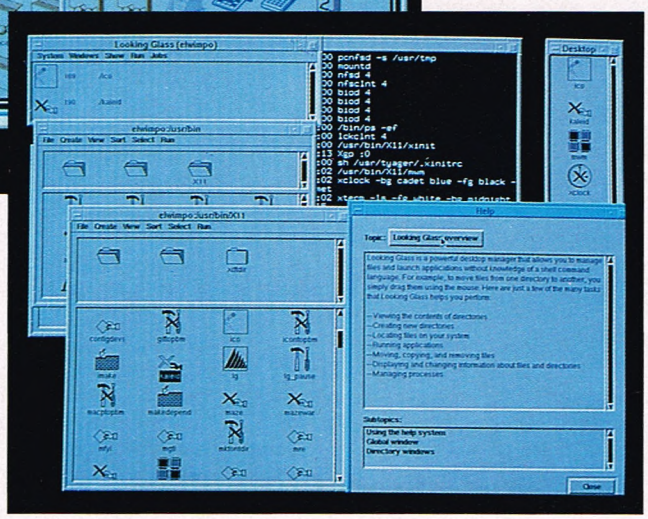


Photo 2: *Looking Glass's interface features pull-down menus and job control.*

Those of us steeped in the Unix religious experience can't understand why everyone doesn't use it. In conversations with the anti-Unix crowd, they say, "It's too hard to use." Until now, there's been no debating that point.

It took someone else to do it, but a layer of simplicity has finally been added to Unix. Two products, IXI's X.desktop 2.0 and Visix Software's Looking Glass 1.0, are jockeying for position as *the* standard desktop environment manager. Both are being bundled with workstations.

These packages represent more than just a pair of pretty faces. Why all the excitement? Consider the Macintosh—it owes its success to the simplicity of its interface. After working with one Mac application, you learn the mouse actions and methods that drive virtually all programs for that environment.

Under the covers, however, the Mac OS is teeming with complexity. It's just hidden from the disinterested, and therein lies the key to a good operating environment: Build in enough versatility to handle any job that comes along, but include a layer for those who "just want to run stuff." And that's just what Looking Glass and X.desktop do.

I installed the software on an ALR PowerVEISA 486/33 with 13 megabytes of memory and a 600-MB hard disk drive. A combination of Interactive Unix 2.2 and Interactive X Window 1.2 formed the software base, with the display served up by a combination of a Paradise 8514/A card with memory expansion, a 512K-byte Orchid ProDesigner VGA, and a Seiko CM-1440 high-resolution monitor.

If you're just starting out with Unix, you'll want to get experienced help in setting things up. Just getting the packages installed requires knowing a little about Unix. Since new users are the main target audience, the software should have been easy, even effortless, to install. While it's not all *that* difficult, I doubt that the average new user could handle it.

With Looking Glass, the necessary license server is not started automatically. Instead, a system has to be designated as the server and the `vls` program run from there. The documentation is lame on this point, and if you follow the directions for starting the program that appear in the front of the manual, they won't work. You'll get a message about a missing license server, but no information about how to start it. The section on the license server appears a few pages later.

Turning the Key

Running either package involves the simple entry of a command, `lg` or `xdt`. X Window needs to be running before you enter these commands, and you can place either command in a user's default X start-up script for an automatic start.

Under X Window, windows cannot be manipulated (i.e., resized, moved, or iconified) without a *window manager*. Both packages conform to the OSF/Motif user interface specification, so the obvious choice is the Motif window manager (`mwm`). Interactive, like many Unix vendors, doesn't ship this standard with its X Window package (it is available separately). X.desktop fills this gap by providing its own window manager, which you can enable with the `-manager` switch from the command line. Looking Glass has no window manager, but it will add a Motif-like border to windows if you're using a window manager (like `uwm`) that doesn't add these adornments.

X.desktop opens one window, the desktop, where all the initial icons sit (see photo 1). The default configuration places icons representing the root and user's home directories, a supplies directory, and a trash can. You can add programs and files to the desktop by dragging them there. Files are not moved anywhere, but a file is marked as a "ghost" in its original location to indicate that it now lives on the desktop.

Double-clicking on any directory icon opens a new window with a view of the files in it. By default, files are represented by icons that convey some limited information. Directories are marked by familiar folder icons, executable files by a console display, X Window executable files by a big X, read-only files with a pair of glasses, and so on.

There are over 90 different icons, but a view of a typical directory is filled with little consoles (executable files) and

X.desktop 2.0

U.S. Contact
UniPress (U.S. distributor)
2025 Lincoln Hwy.
Edison, NJ 08817
(800) 222-0550

European Contact
IXI, Ltd.
62-74 Burleigh St.
Cambridge CB1 1OJ
UK
44-223-462131

Hardware Needed
Graphical display and pointing device; 4 MB of free disk space

Software Needed
X Window System 3.0 or higher; compatible Unix operating system (various); Motif window manager (optional)

Price
Single-user version: $495
(Site licenses available)

Inquiry 1018.

Looking Glass 1.0

Company
Visix Software, Inc.
11440 Commerce Park Dr.,
Suite 600
Reston, VA 22091
(800) 832-8668

Hardware Needed
Graphical display and pointing device; 4 MB of free disk space

Software Needed
X Window System 3.0 or higher; compatible Unix operating system (various); Motif window manager (optional)

Price
$495 to $1295, depending on platform

Inquiry 1019.

stacks of paper (regular files). A screen full of identical icons is just clutter. Thankfully, directory windows can also be set to display filenames. This is fast and useful. Each name has a tiny icon to its left with a symbol that clearly shows whether it is a directory, executable, or regular file.

Directory views can be sorted in a number of ways. All X.desktop menus appear as pop-ups; you hold down mouse button 1 in the background area of any X.desktop window. This can be a bit confusing—there's no clue that a menu lies in wait.

Whether in an iconic or text view, files are manipulated in the same manner. A single click selects a file, and a double click opens (with an editor, for example) or executes it. Dragging an icon to a different directory moves it, and dragging while pressing mouse button 2 copies it. Clicking on an icon's name brings up a window that lets you change the name.

Clicking on a file and invoking the View option from the pop-up menu displays that file's characteristics. If you have the access rights, you can modify a file's permissions with a few clicks. An annoyance is that the file type is represented as a four-character jumble that almost requires that you have a crib sheet nearby to decipher it.

The supplies directory, shown as an office supply cabinet, is intended to hold utilities for backups, printing, and other low-level needs. As it is an ordinary directory, any executable can be copied or linked into the cabinet.

Looking Glass's desktop metaphor is spread across the entire screen (see photo 2). It initially opens three windows: a control window with pull-down menus that control Looking Glass and perform other functions, a desktop window that holds frequently used application icons, and a directory view. Unlike X.desktop, Looking Glass uses pull-down menus exclusively. The control window and directory views have their own menu panes.

Icon actions are only slightly different from X.desktop; to copy a file, you drag it with mouse button 1 *and* the Control key pressed.

Looking Glass's directory view is its best feature. It is a dual-paned window, with a horizontal sash separating the directories from the files. The sash can be moved to any position, changing the ratio of visible directories and files.

There are hundreds of file icons, all well drawn and most of them explicit in their description of the file type. The level of detail is extraordinary—many icons map to specific named files. Opening a directory view on /bin, for instance, shows unique icons for the first twelve files in that directory. Most common (and some not so common) commands have icons bound to them. That is the first feature that makes Looking Glass a more useful iconic environment: The default icons *mean* something.

The directory view can also be expanded to a list of names, and here, too, Visix outdid itself. The narrow view simply lists columns of files, similar to the output of `ls`. But selecting Wide from the pull-down menu brings up every piece of information Unix knows about the file, arranged in a useful columnar report. Each column is topped by a small window containing the title. The column titles can be picked up and moved to other locations or discarded, creating a totally customized viewing format.

One of the informational items shown in the Wide view is something that Looking Glass figures out for itself—the file type. In order to attach a descriptive icon to some files, Looking Glass tries to determine the file type. This can involve anything from looking up the filename in a table to opening the file and reading enough of its contents to guess the type (as the Unix `file` command does).

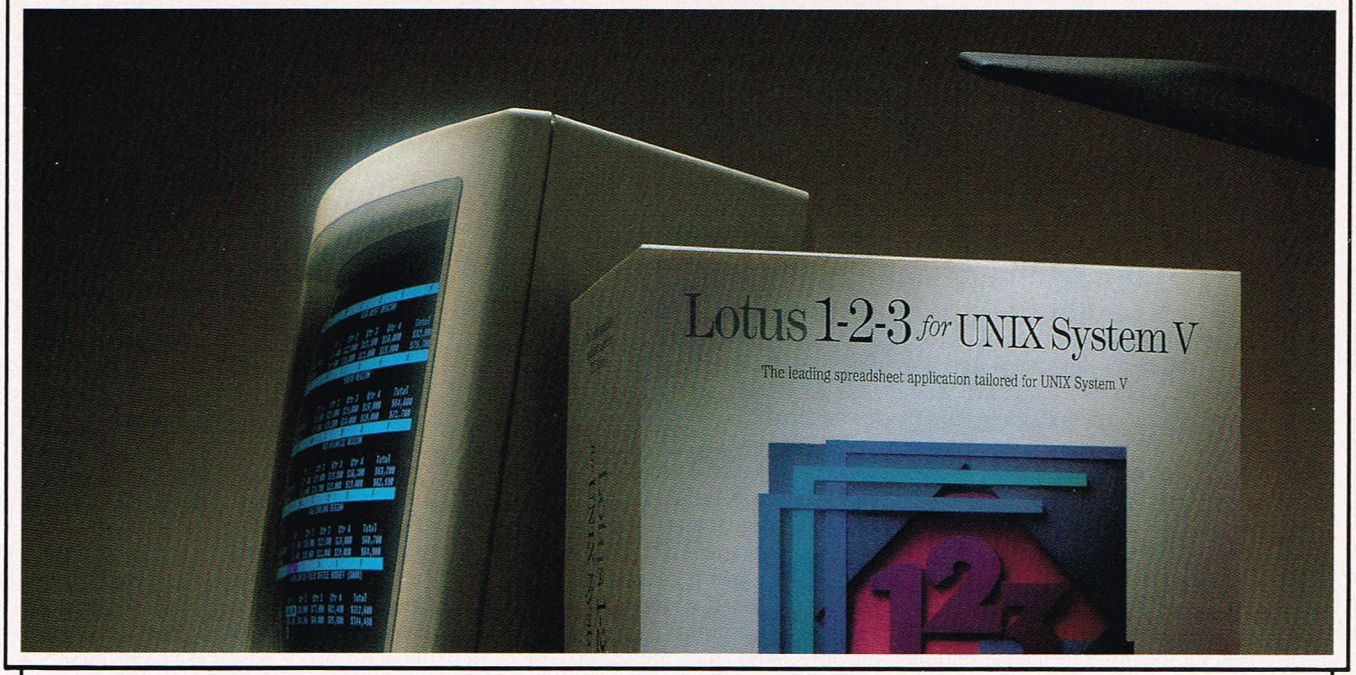
Opening a large directory for the first time can be slow as Looking Glass sifts through the files, attaching type data to each. File types are kept in a separate data file, `.lgdb`, to save the trouble of regenerating the types every time a directory is opened.

Looking Glass also has a virtual desktop window into which you can put commonly used programs and files. The control window, in addition to holding the main menu, serves another interesting purpose. Whenever an application is launched from within Looking Glass, its icon and associated command appear in the control window. Clicking on the icon there and selecting a menu option will let you kill the application, gracefully or forcefully. This may seem minor, but it makes Looking Glass a nearly complete environment. Killing errant processes is also one of the most confusing things for new users to learn; this makes it a snap (or, rather, a click).

Making Them Your Own

A large part of working with any graphical environment is tuning it to your own preferences. With Looking Glass, this is simplified somewhat by the set-it-and-forget-it approach: The window placements and settings you used during your last session are restored in later ones. But to go deeper than mere cosmetic adjustments, both packages give you two options: icon editing and rule files.

If you don't find an icon that expresses what you have in mind, you can create one. X.desktop uses the X Window program `bitmap`, while Looking Glass includes its own. The advantage to using



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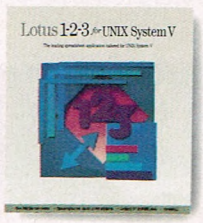
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bitmap is that files are stored in a standard X Window bit-map format and can be generated and used by other X Window programs. Looking Glass stores its bit maps in a proprietary-format file.

Looking Glass rule files add recognition for file types that are unsupported by the base software. Attributes can be attached to file types to set whether they need to run in a terminal emulator window, whether a command can accept multiple filename arguments, and whether printing applies to the file and how it should be handled. These definitions are compiled for faster access. Even though Looking Glass can be extended with specialized file types, its *behavior* can't be changed. There is no way to attach a special meaning to mouse button 3, or to change the action taken when a file is deleted.

This is where X.desktop really shines. It comes complete with a full-featured programming language, which can be used to change every facet of X.desktop's behavior. Each icon type has program code associated with it that determines how mouse-clicks (including multiple clicks) and drags affect it, and how it interacts with other icons.

Using the language, for example, a Gateway icon could be created and attached to a directory. Dropping files on that icon might copy them to another system on the network. Interaction with the user can be arranged through utilities included with X.desktop that pop up message windows and take user input from the keyboard.

The language is also extended to shell scripts and to the command line through the tellxdt command. Any X.desktop programming language command can be sent to xdt from the outside this way. Although it would take some doing, you could create entire domains of specialized icons that are tuned to a particular purpose. And since the scripts are all in plain text files, they are easily exchanged between systems.

Telling Them Apart

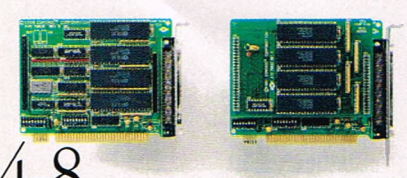
In general, I am impressed with both products. Looking Glass is much more useful out of the box. With more standard icons, job control, and flexible methods for looking at files, it can appeal to both new and experienced Unix users. It doesn't pander, but neither does it force you to understand anything about Unix. Users at any level could live comfortably under Looking Glass.

X.desktop, on the other hand, is less immediately useful but much more adaptable to specific requirements. Experienced users will delight in tinkering with its programming language, wrapping themselves in a custom environment that is uniquely their own. New users can get by, but will gain little from X.desktop until a helpful hacker comes along and adds some new behavior. If I were a system administrator charged with placing 20 workstations in the hands of new Unix users, I'd spend the time to write custom X.desktop programs that would make the users' lives easier and cut down on the number of problem calls.

So if you stop me on the street to tell me how Unix isn't for you, you had better prepare yourself. With X.desktop and Looking Glass out there, you're clean out of excuses. ■

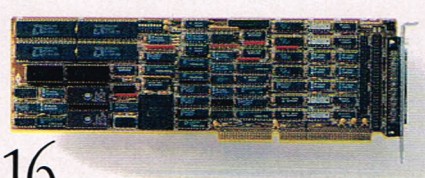
Tom Yager is a technical editor and Unix expert for the BYTE Lab. You can reach him on BIX as "tyager."

Multiple-Choice



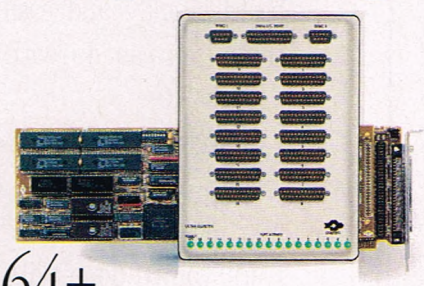
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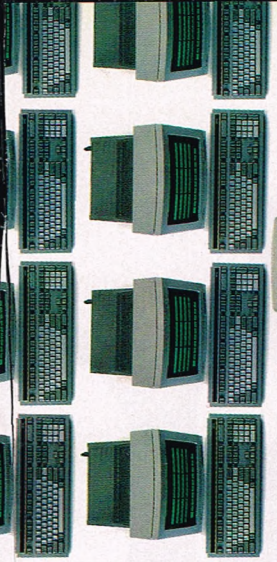
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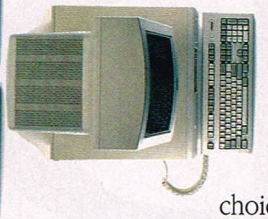
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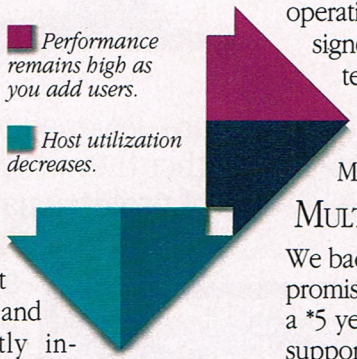
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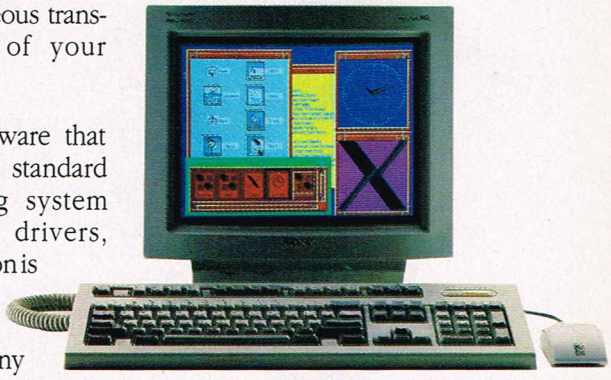
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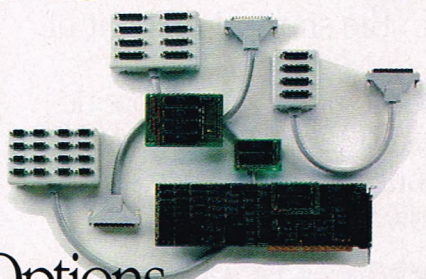
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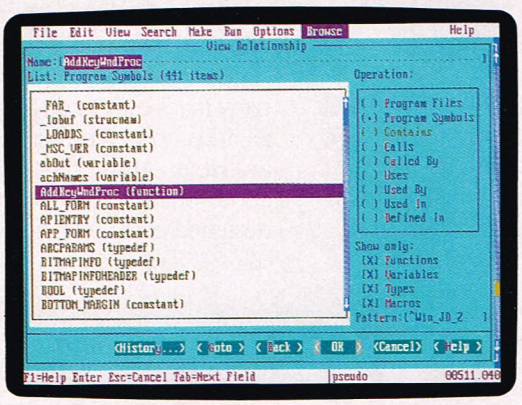
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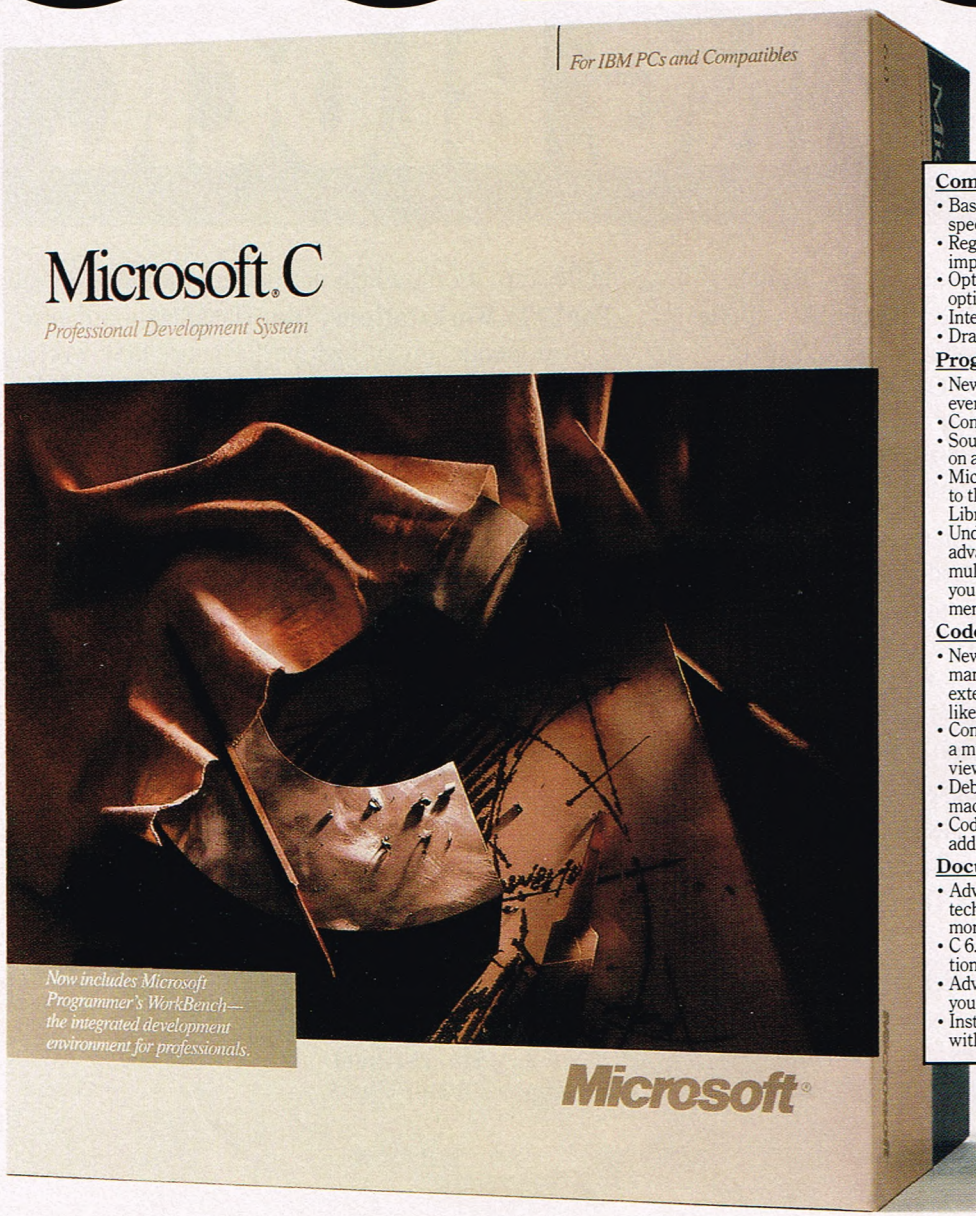
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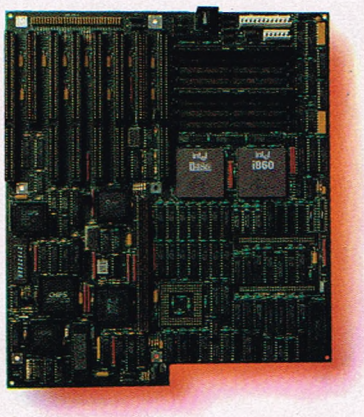
Documentation

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- C 6.0 Reference: Reference guide covering options and reference to runtime library routines
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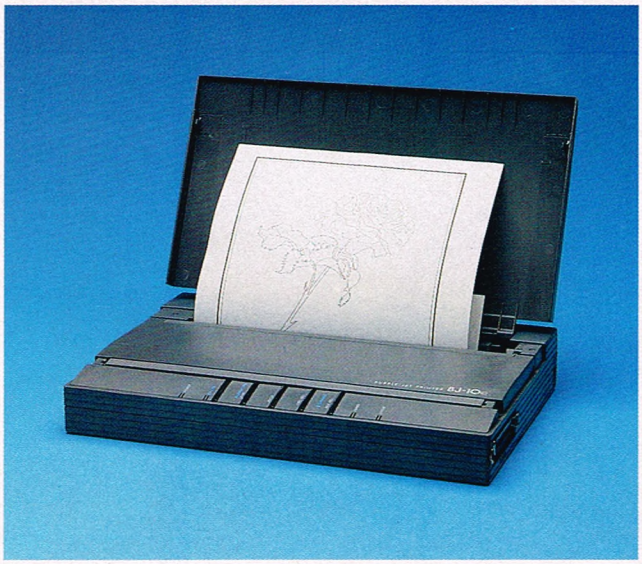
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Circle 155 on Reader Service Card

Alan Joch

REVIEW

New Bubble-Jet Outpaces Portable Printers



The BJ-10e uses a nonimpact bubble-jet print mechanism that can produce 360- by 360-dpi resolution text and graphics.

If a colleague produces an important document with Canon's new BJ-10e printer and asks you to check the fine print, legalese may be the furthest thing from his or her mind. Instead, your cohort may be referring to the crisp, 360-dot-per-inch resolution coming from this impressive portable.

The BJ-10e serves users of PCs (and Macs, through third-party vendors) who print more than notes to themselves on cross-country flights or while hunkering down in a hotel room. The $499 printer can deliver high-quality letters and reports that you'll feel fine about distributing to your business contacts. In return, you'll pay weight and size premiums compared to portables like Kodak's Diconix 150 plus. Yet neither its 4 pounds (versus Diconix's 3 1/10 pounds) nor its 12¼- by 8½- by 2-inch dimensions take the BJ-10e out of the portable arena. Its sharp, 360-dpi quality, however, does separate it from the portable pack. In fact, the BJ-10e surpasses the quality of some full-size, desktop ink-jet printers at four times the price.

BJ-10e

Company
Canon U.S.A., Inc.
One Canon Plaza
Lake Success, NY 11042
(516) 488-6700

Hardware Needed
PC with parallel interface, or Macintosh with optional serial-to-parallel cabling interface

Price
$499

Bubble Brigade

The "BJ" in the printer's name stands for *bubble jet*, a nonimpact print mechanism closely related to ink-jet technology, except that air bubbles force ink from any of 64 nozzles. An electrical charge produces the bubble, and the resulting heat dries the ink almost as it hits the paper. Canon claims that the ink won't smear, but that's not entirely true. Careless fingers will cause smudges if you touch a fresh page. Let the ink dry for a couple of minutes, though, and a single pass of a highlighting pen won't do any damage. (Multiple passes will muddy your prose.)

To prevent ink evaporation, a small arm caps the print head when the BJ-10e is idle. I left the printer unused for three weeks and then reinstated it without any dried-ink problems.

This is Canon's second bubble-jet printer now on the market. Last year, the company began shipping the BJ-130e, a desktop version capable of 132 characters per second in letter-quality mode. Canon hints that more bubble-jet printers are in the offing, possibly including a color model sometime in 1991.

Unlike the desktop BJ-130e's print mechanism, which consists of a separate ink cartridge and print nozzles, the BJ-10e uses a cartridge that integrates both elements. Canon rates BJ-10e cartridge life at 700,000 characters, or about 200 single-spaced pages, according to my calculations. The $25 cartridges don't leak or spill ink, and they snap into place easily.

Using DIP switches, you can select either BJ-130e or IBM Proprinter X24E emulations. Currently, you must emulate the BJ-130e using packages that offer the correct software drivers to achieve full 360- by 360-dpi graphics resolution. Graphics in Proprinter X24E emulation are limited to 180- by 360-dpi resolution, although Canon says it is working with software vendors to develop drivers for full graphics resolution in that mode.

Software drivers written for the BJ-130e are compatible with the portable version, including Windows (Windows 3.0 drivers were being developed at press time), Microsoft Word, WordPerfect 5.0, QuattroPro, First Publisher, and three PostScript interpreters: UltraScript from QMS, TeleTypesetting's TScript, and GDT Softworks' JetLink Express 2.0. QMS, GDT Softworks, and TeleTypesetting also offer software drivers and serial-to-parallel interfaces that let you hook up Macs to the BJ-10e and print at full resolution.

Clamshell Alliance

The BJ-10e's self-contained case and charcoal color resemble the clamshell portable computers on the market. While the BJ-10e is a natural for the road (a rechargeable battery pack weighing about 9 ounces is a $50 option), Canon markets it as a portable that doesn't have to hibernate between business trips. A built-in stand and optional ($90) 30-sheet paper feeder mean you can set it up on your desk as a backup printer to dash off short letters and memos that you don't have to track down at the networked printer.

You'll sacrifice little in the way of print quality. The BJ-10e prints in either a so-called economy or a high-quality mode. Print speed remains the same in either case, but in the economy mode less ink shoots out to print characters, for longer cartridge life. Characters sit on the page clearly defined; put a magnifying glass to them and their jaggies show, but the quality isn't too far from a laser

```
"Good-by, Grover's
Corners...Oh,
earth, you're too
wonderful for
anybody to realize."
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"Good-by, Grover's
Corners...Oh,
earth, you're too
wonderful for
anybody to realize."
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"Good-by, Grover's
Corners...Oh,
earth, you're too
wonderful for
anybody to realize."
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Figure 1: *Text samples from a LaserJet Series III (top), the Canon BJ-10e (middle), and Epson's EPI-4000 ink-jet printer rank the BJ-10e's output closer to laser-printer quality, thanks, in part, to fewer jaggies on the edges of characters.*

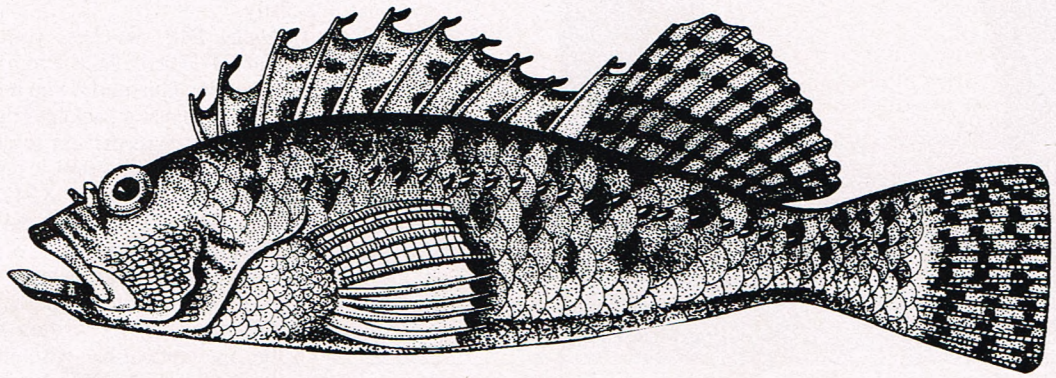


Figure 2: *In its unidirectional graphics mode, the BJ-10e printed this 360- by 360-dpi line drawing from a file created by Canon.*

printer's. In fact, when I pitted the BJ-10e's output against the Hewlett-Packard LaserJet Series III and a full-size Epson EPI-4000 ink-jet printer, the BJ-10e came in a comparatively close second to the laser printer (see figure 1).

I printed samples on plain xerographic stock and 25 percent bond letterhead with fine results. The BJ-10e will not break any speed records; mine averaged about 75 seconds to print a full page of text in high-quality mode. But the bidirectional print (in text mode) doesn't make you feel as though you're waiting an inordinate amount of time.

The automatic sheet feeder does away with the frustrations of loading paper one page at a time. It automatically handles letter-size paper; you can print on A4 sheets if you feed the paper in manually. The feeder doesn't accept envelopes, but the printer handles them easily through a rear path. Printing continuous forms is not part of the printer's capabilities.

The feeder worked without hanging up, even on a series of 10-page text files. However, printed pages tend to gather in a clump after they exit the printer and may foul exiting sheets.

I printed a line drawing in 360-dpi resolution and found the tones to be an impressive range from solid black to white, with sharp definition of crosshatches and other patterns (see figure 2). The printer slows down a bit with graphics because it switches into a unidirectional print mode, but the clarity and resolution of the final image make the wait worthwhile.

Another plus is the printer's quiet operation. Step into a coworker's cubicle while the BJ-10e is running, and you're more likely to hear the occasional clank of the paper rollers than the print nozzle.

Bubble Trouble

Nevertheless, this handy peripheral is not without some unnerving flaws. The user's manual is so perfunctory that you will wish it came with Cliffs Notes to help you decipher it. I found myself reading some confusingly written sentences over and over, trying to glean their meaning. Don't scour the manual for a technical-support number, because one isn't listed. The manual tells you to call your service representative, but don't be deterred. Dial (800) 423-2366 and you will reach Canon's support line. I called anonymously and received immediate and knowledgeable service. Canon's fledgling BBS, at (516) 488-6528, posts a few new software drivers.

I also found myself cringing at the printer's frequent chirping. The printer chirps in lieu of control-panel lights that tell you if you're in draft or letter-quality mode and whether you're set for pica, elite, or double-high characters. As you press control buttons, you hear a series of chirps in a variety of tones to guide you in your selections. The chirps attracted a stream of coworkers into my cubicle wanting to know what new computer game I had found. So hope that anyone sitting next to you on a crowded flight is patient or plugged into a headset.

Worst of all, I found these audio codes confusing and frustrating—I was never sure of the setting until the printer actually started producing text. If you're hearing-impaired, this printer may be impossible to use conveniently.

Over time, I grew more comfortable with the control panel, but I would still prefer a more intuitive visual display. Even so, Canon may have a hit. Laptop owners who want high-quality output from a portable printer that can serve double-duty on the desktop should consider this bubble-jet printer. The price alone should make you feel, well, positively effervescent. ■

Alan Joch is a BYTE technical editor. You can reach him on BIX as "ajoch."

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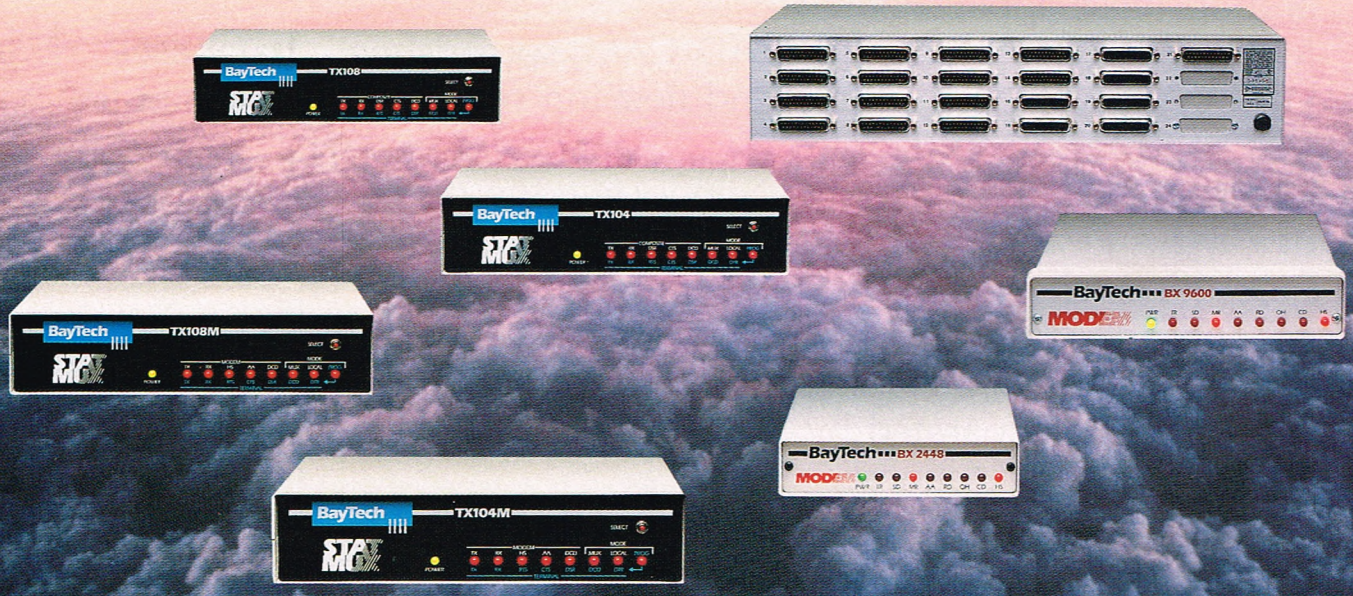
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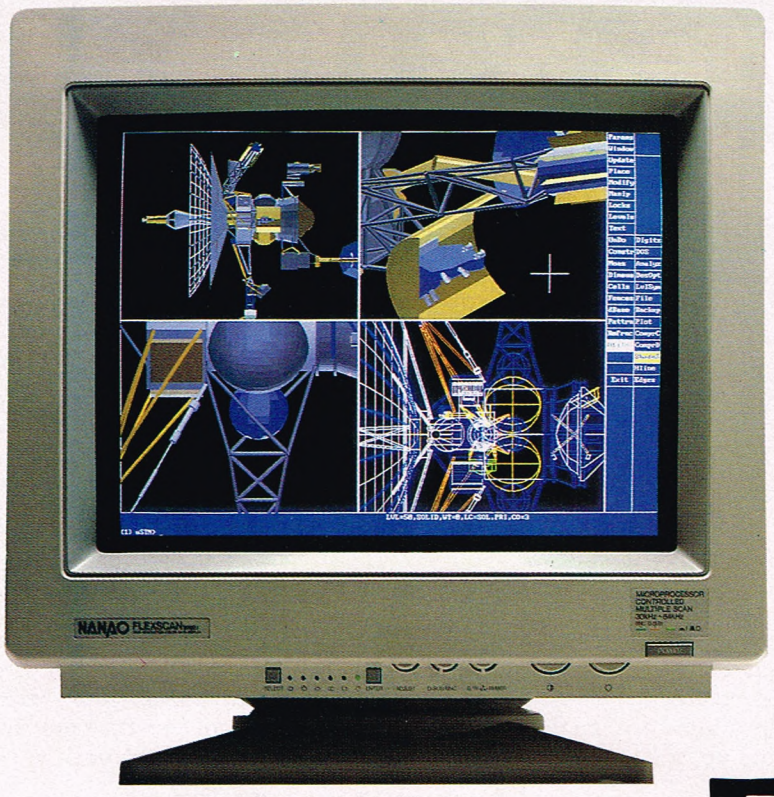
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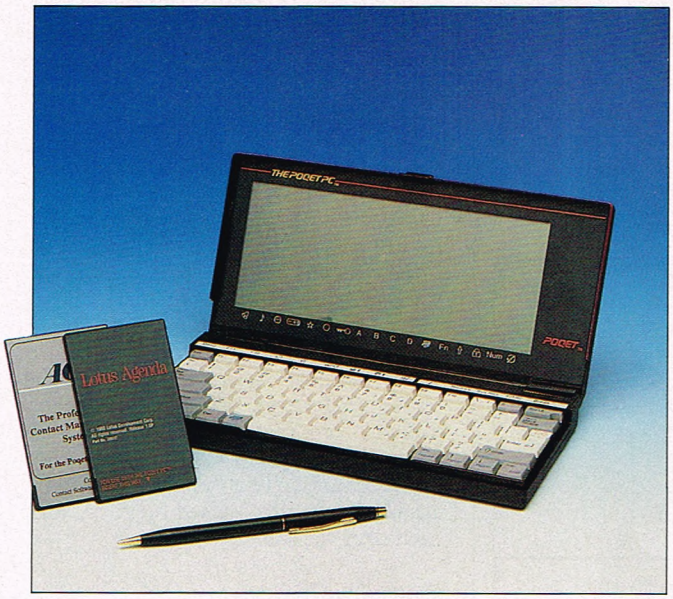
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Wayne Rash Jr.

REVIEW

A Poqet Full of Power



The Poqet PC weighs only 1 pound, and programs such as Lotus Agenda and Act are available on ROM cards made specifically for it.

Poqet PC

Company
Poqet Computer Corp.
650 North Mary Ave.
Sunnyvale, CA 94086
(800) 624-8999, ext. 1590
(408) 737-8100

Components (as reviewed)
Processor: 7-MHz 80C88
Memory: 512K bytes of RAM; 640K bytes of ROM
Mass storage: 64K-byte RAM card; 512K-byte RAM card
Display: 7- by 2⅞-inch supertwist LCD; MDA mode 25 rows by 80 columns, CGA mode 640 by 200 pixels
Keyboard: 77-key
I/O interfaces: XT bus edge connector

Size
8¾ × 4³⁄₁₀ × ⁹⁄₁₀ inches; 1 pound

Price
$2345

Inquiry 1082.

Poqet Computer's Poqet PC is a remarkable device. Whether you see this tiny computer as a workhorse or an executive toy, a 1-pound, IBM PC–compatible computer slightly larger than a pocket calendar that runs for 100 hours on two AA alkaline batteries is indeed a technical achievement.

The basic Poqet includes 512K bytes of system RAM, 640K bytes of ROM, a 64K-byte RAM card, a file transfer cable, and a carrying case for $1995. My test machine also included a 512K-byte RAM card ($350) and special ROM-card versions of Act ($395), XyWrite ($495), and Lotus Agenda ($395). Built around a 7-MHz 80C88, the machine is slightly faster than an IBM XT.

When BYTE first saw the Poqet (see "A PC in Your Pocket," November 1989), it was clear that this was not a machine for everyone. At the time, the computer's LCD had clarity problems, and the miniature keyboard was impractical for any task that required more than a few keystrokes. The display problem is fixed, and the keyboard is improved, but the keyboard's small size still limits the machine's usefulness.

The keyboard and screen are just two of the compromises required to create a computer the size of the Poqet. Another is the machine's 512K-byte system RAM limit—the Poqet simply doesn't have enough room inside for more memory. This limitation is less of a problem than it sounds, however, since programs in the Poqet's 640K bytes of internal ROM (i.e., DOS 3.3, GWBASIC, PoqetTools, and PoqetLink utilities) or on optional ROM cartridges don't have to be loaded into RAM to execute.

Tiny Typing

The Poqet's keyboard has a 77-key QWERTY layout with 10 function keys across the top and a numeric keypad superimposed over the letter keys on the right side of the keyboard. You activate the keypad by holding down the blue Poqet key next to the space bar. This key also activates several other secondary functions on the keyboard.

Some Poqet-key combinations simply invoke lesser-used keys on standard keyboards, such as the F11 and F12 keys. But the Poqet key also controls several special functions, including contrast and brightness controls, power management, the keyboard lock, and the alarm and speaker controls.

Pressing Poqet-Escape invokes PoqetTools, a SideKick-like pop-up menu that includes a calculator, a text editor, a scheduler, an address book, and a communications program. The menu also includes a setup utility that controls power management and other functions.

The keyboard, which measures just 8½ inches wide, performs well for its size, although the ½-inch-square key caps are so small and so closely spaced that you probably won't want to do any touch-typing. Still, touch-typing is not impossible, as one of my coworkers (who has very small hands) demonstrated.

The Poqet never truly shuts off. Pressing the I/O key, just above the Return key, shuts off the display and CPU but continues to power memory to protect programs and data. When you reactivate the machine, it returns to the state it was in before you deactivated it. Even during normal operation, the CPU goes into sleep mode between keystrokes, and the system shuts down the display after sitting idle for 2 minutes.

Peering Ahead

The 7- by 2⅞-inch screen presents a full 25 rows by 80 columns in either CGA or MDA mode. The default is MDA. The characters, while small, are crisp and easy to read: They're about the same size as the text on this page.

Although the screen does not have backlighting, it's still possible to use it under average lighting conditions. The screen folds to any angle, but it will not fold open completely if you have a serial cable or data transfer cable attached to the machine. Along the bottom of the screen are indicator blocks that tell, among other things, function-key status, when you're accessing the ROM disk, when the battery is low, and when the power management software is enabled.

The Poqet is free of external controls

and connectors, except for a single XT-bus edge-card connector at the rear of the unit that accepts a data transfer cable (which is included) or an optional serial or parallel cable, and two memory-card slots on the underside that hold RAM or ROM cards.

RAM cards, used for data storage, come in 64K-byte and 512K-byte sizes; a 1-MB card was still in development at press time. My test unit included a 512K-byte RAM card. Despite a recent price cut (the 512K-byte card dropped from $595 to $350), the cards are an expensive way to store data. One alternative is to configure the Poqet's 512K bytes of system RAM as a RAM disk. Another is to buy Poqet's external 3½-inch 1.44-MB floppy disk drive for $395, but this reduces portability and cuts battery life down to 20 hours. An optional memory-card reader for desktop PCs, which was unavailable at press time, should make using the cards more convenient.

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Moving Bits

The Poqet's file transfer cable attaches to the serial port of your desktop computer. Using PoqetLink, you can send and receive files at 115,200 bps. If you can find enough room in RAM, standard IBM PC software will work. I was able to use the Norton Utilities and WordStar 4.0 without problems. Other packages, including WordPerfect, wouldn't fit on a 512K-byte RAM card.

Poqet has received a great deal of cooperation from software vendors, who have ported their packages to ROM cards for use in the Poqet. ROM and RAM cards slide like tiny drawers into slots in the bottom of the Poqet's case.

I tested three ROM card applications: Lotus Agenda, Act (a business-contact tracking package), and XyWrite. Other available programs include Lucid 3-D, Lotus 1-2-3, AlphaWorks, and Lotus Metro/Express. Each program operates exactly like its disk-based brethren, and each costs the same.

Poqet the Difference

Despite the Poqet's technical accomplishment, I didn't find the machine useful. I was unable to make it slide into an inside jacket pocket, so the computer had to stay in my briefcase, where it wasn't as handy as a scheduler. It's also too small for most people to type on to any extent. A Poqet user, it would seem, has to be satisfied with writing brief memos and working with small spreadsheets. That's a fairly limited use for a machine that costs about $2000.

Poqet Computer markets the machine to field salespeople and some managers. But even these people are likely to be better served by a notebook-size computer, such as the Zenith MinisPort or the NEC UltraLite. Each of those machines has a more usable keyboard and a disk drive, and each is about twice the size of the Poqet. Each also costs less in its base configuration than the Poqet.

Whether the Poqet is an executive tool or an executive toy is for you to decide, but as powerful as it is for its size, the machine's form factor ultimately limits its effectiveness. In this case, the size seems just a bit too small. ■

Wayne Rash Jr. is a BYTE contributing editor and avid laptop user. He is also technical director of the Network Integration Group of American Management Systems, Inc. (Arlington, VA). He consults with the federal government on microcomputers and communications. You can contact him on BIX as "waynerash," or in the to.wayne conference.

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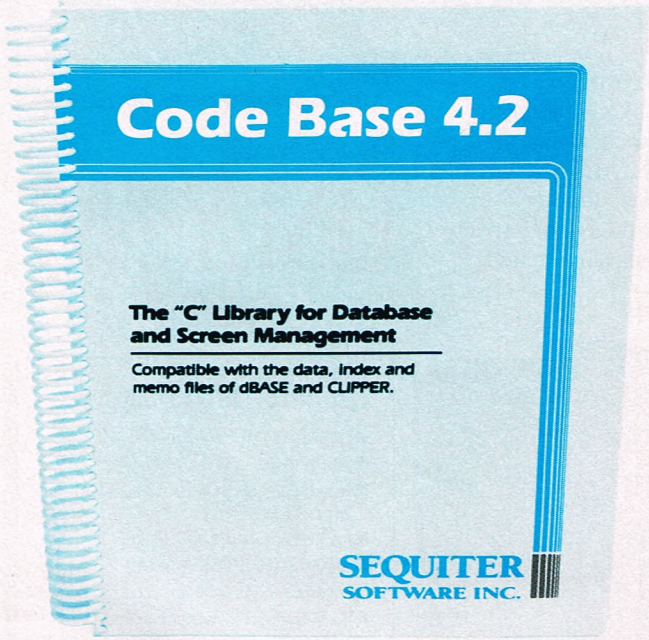
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Barry Nance

REVIEW

One-Size-Fits-All Code with Lattice C

No one can argue this: Software portability is now more important than ever. The problem for developers, though, is that creating a program that runs under DOS, extended DOS, and OS/2 is no easy task. Often it means collecting a huge library of disjoint programming tools. And if you also consider the increasing importance of Unix, the problem becomes even bigger.

Lattice's newest C compiler package, the 80286 C Development System for DOS and OS/2, addresses much of this concern. It enables developers to create programs that run under DOS, extended DOS, and OS/2. The kicker is that, with Lattice, all three environments can be supported by a *single* executable file. And Lattice includes over 800 functions, many of which mirror Unix calls.

Other development environments exist, of course, that let you use extended memory (i.e., separate third-party DOS extender products, OS/2 itself, and the 386 enhanced mode of Windows 3.0). But Lattice is the first major compiler vendor to *include* a DOS extender with its compiler that gives DOS programs access to 286 or 386 extended memory. There are no fees or royalties when you distribute the Lattice extended DOS facility with your application. And the users of your application do not necessarily have to upgrade to OS/2 when your software starts running out of RAM.

Lattice 80286 C Development System for DOS and OS/2

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Lattice, Inc.
Subsidiary of SAS Institute, Inc.
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Software Needed
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The Shootin' Match

The new Lattice development environment includes all the tools and library routines of the regular compiler product (version 6.0). You get a full-screen symbolic debugger, CodeProbe, that runs under both DOS and OS/2. The LASM assembler is mostly compatible with MASM, although it does not handle MASM-style memory-model directives and some assembler macros.

For projects with many source code modules, a make utility (LMK) is supplied that is a superset of the Unix `make`. EXTRACT and BUILD utilities are also supplied to help you create your make files. Other utilities let you find and optionally change all occurrences of a specified string in your source code files as well as produce source code statistics. Lattice provides its own linker, bind program (for constructing family mode applications), and object file librarian.

The standard library is fully ANSI compliant and incorporates many functions you'd find in a Unix environment. Lattice has added several useful functions of its own to the standard library: The "build string list" and "sort string list" functions are examples of routines that tempt you to forgo strict ANSI coding in your programs. In addition to the standard library of functions, Lattice gives you these application libraries:

- Communications Library: supports XMODEM, YMODEM, and Kermit.
- Database Library: creates and manipulates dBASE III–compatible files.
- Graphics Library: has several drawing routines, but limited font support.
- Screen Management Library: text-mode routines very much like Unix `curses`.

Installing, Tuning, and the Dongle

The installation of the Lattice 80286 C compiler and its tools is straightforward. Basically, you choose whether you want OS/2 support, and you pick the memory models you want; the installation program then puts the files into the correct directories. It requires about 5 megabytes of disk space. To take advantage of the features of this compiler, I used my Gateway 2000 386/33 computer as a test bed. It has 4 MB of extended memory, and I regularly use it for both OS/2 and DOS development work.

The installation process is noteworthy in two ways. First, you must let the DOS extender software "learn" about your hardware by running the TUNE utility. TUNE attempts to find the fastest way to enter and leave protected mode on your system, possibly crashing your system in the process. Users of software you produce with Lattice's extender will have to TUNE it, as well.

Second, Lattice decided to copy-protect this compiler product with a hardware device, called a *dongle*, that attaches to your parallel port. The dongle sits transparently between your printer cable and the parallel port. There is no mention on the package about any sort of copy protection. Frankly, I was annoyed by the implications of copy-protecting a professional software development tool.

Compiling Your Code

To check out the compiler, I created extended DOS versions of the LAN-aware programs that accompany my book *Network Programming in C*. I also compiled the Dhrystone benchmark program. Comparing the size of the resulting executable files with the output of other C compilers proved difficult. The bound family mode version of any program is naturally larger than a pure DOS or pure OS/2 version. Being able to create a single executable file that works correctly under DOS, extended DOS, OS/2, and the DOS compatibility box is an impressive feat.

Performance-wise, the Lattice compiler emits code that is comparable to that of other C compilers. The Dhrystone benchmark ran in 5 seconds no matter which C compiler I used. The results were consistent when I ran the program in DOS mode, in extended DOS mode, and under OS/2.

When you tell the compiler to optimize your code, it invokes a separate step (the global optimizer, LGO) just prior to linking. Because the optimizer gets to see as much of the emitted object file as it wants, the optimizer can make intelligent decisions about what to streamline.

The Lattice debugger is a command-line debugger at heart.

It looks for opportunities to turn functions into in-line code, eliminate dead code assignments, perform peephole optimizations, eliminate common subexpressions, and do other things to make your code faster (or smaller, depending on what you specify).

If you have variables marked `volatile`, the optimizer won't eliminate references to them. Likewise, if you have a function that calls itself recursively, you can control the depth to which the optimizer "unrolls" the code as it transforms called subroutines into in-line code.

The Lattice Toolbox

The Lattice debugger, CodeProbe, operates in full-screen mode but is a command-line debugger at heart. Interestingly, when you choose a CodeProbe menu option, the software emits a line of debugger commands to itself. This internal discourse is visible in the debugger's dialog window. CodeProbe works in DOS, extended DOS, and OS/2 modes. It supports conditional breakpoints, data watches, slow-motion execution, and other customary debugger facilities.

The text editor that comes with the Lattice compiler, LSE, is adequate for most programming purposes. It's quick, has an interface to the Lattice compiler, and allows multiple source code files to be edited in multiple windows. Several other tools are provided with the compiler. The linker, LMB, supports both code and data overlays.

The screen management routines that you get with the compiler are a close adaptation of Unix `curses`. I was able to easily move a small Unix program from an IBM RS/6000 AIX machine to my Gateway computer and compile it for OS/2. I smiled inwardly to see a typical `curses` user interface appear in an OS/2 session when I ran the program.

Lattice does not supply a hypertext on-line reference with its compiler, although, of course, each part of the development environment has an associated help file that you can access. Speaking of help, the on-line support for the Lattice compiler that has been available for years on BIX has been discontinued by Lattice's parent company, SAS.

The Lattice 80286 C Development System for DOS and OS/2 is a well-documented, high-powered environment. As I put the compiler and tools through their paces, I tried to visualize myself as a developer who has a memory-hungry application. Faced with the decision to shoehorn my software and stick with DOS or force my customers to upgrade to OS/2, I'd see the Lattice DOS extender as a welcome alternative. And the `curses` interface might encourage me to port my application to run under Unix so I could take advantage of that marketplace as well. But as good as this compiler is, Lattice may have tied a millstone around its neck with the copy protection. ■

Barry Nance is the author of Network Programming in C *and is the exchange editor for the IBM Exchange on BIX. He can be reached on BIX as "barryn."*

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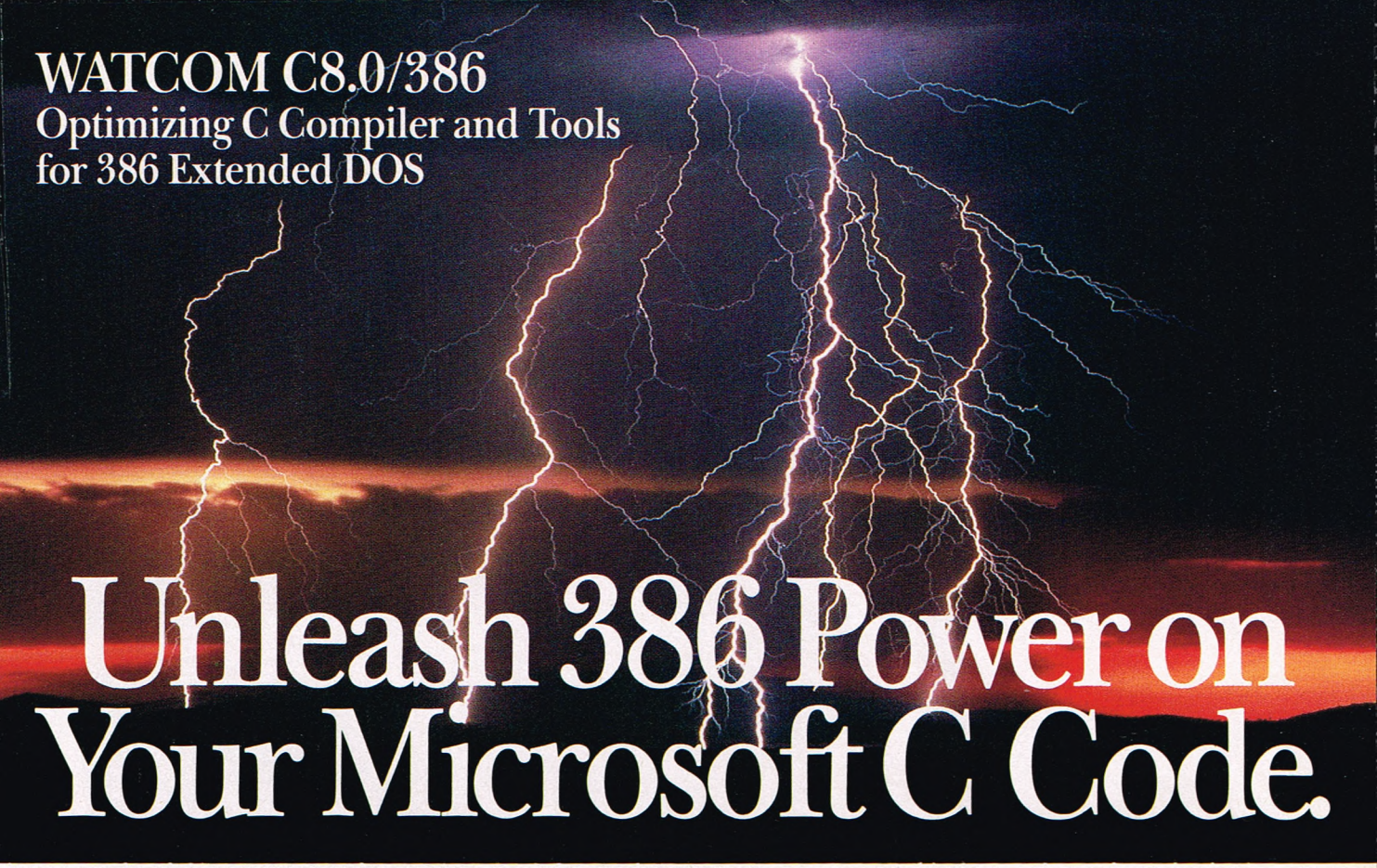
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Doug Dayton

REVIEW

Document Management on Networked PCs

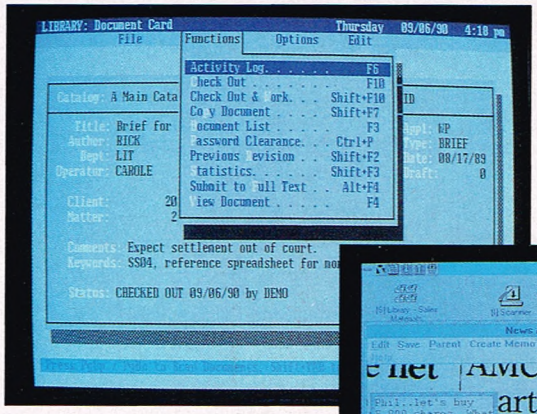


Photo 1: *ProFound's card catalog keeps track of several important document statistics and searchable field descriptions.*

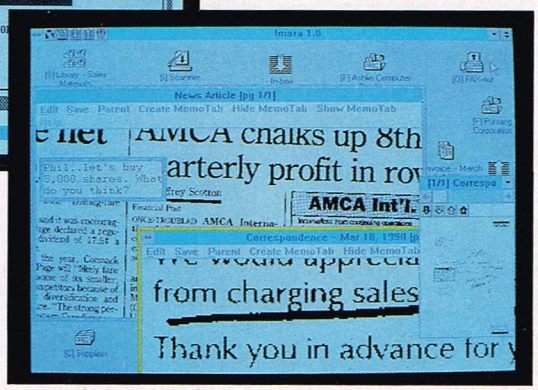


Photo 2: *Imara lets you attach electronic notes called MemoTabs to document images.*

As the number of files on a network increases, locating files becomes more difficult, and tracking multiple versions of a document becomes virtually impossible. Time is often wasted by working with out-of-date documents, and file access becomes harder to control. Perhaps most worrisome, frustrated system users may become less disciplined about file backups and may resort to archiving documents instead of simply deleting their obsolete files.

ProFound, from Wang Informatics Legal & Professional Systems, and Imara, from Imara Research, take two different approaches to the problem. ProFound is a character-based DOS application designed to help manage word processing and other live documents on a network; Imara is an OS/2 Presentation Manager–based application that manages graphics and documents that have been stored as image files.

Both Imara and ProFound support distributed (client-server) computing by enabling files on different file servers to be stored and accessed transparently across a network. And both products use the metaphor of a library with a document catalog to control access, storage, and archiving of files that have been checked into their databases.

Imara is aimed at companies moving toward a paperless office. Imara users scan or import paper documents into Imara's Structured Query Language (SQL) database as compressed Group 4 fax files. Then Imara's image documents are shared among different workgroup members using Imara's built-in E-mail facility (called I-mail).

ProFound provides a more pedestrian solution to document management, relying on the character-based DOS interface and working with files created using word processors, spreadsheets, or other applications. ProFound's mainstream solution contrasts sharply with Imara's attempt to redefine how office workers share information. But while both products provide features that can help you manage your distributed office systems, neither provides a complete solution to the problem of distributed file management.

ProFound Document Libraries

ProFound helps network administrators manage their users' file requests and document storage requirements by automatically copying, distributing, and backing up their documents across multiple file servers. When you first start ProFound, you can go into one of two areas: the work area or the library.

The work area is where documents and files are created and edited. A catalog card is automatically created in the work area as each new document is created, and it is updated when any revisions are made.

You can configure ProFound to automatically start the application you will be using after you create your catalog card. After a document is created or revised, ProFound checks it into the library. The library contains one or more catalog files that contain a catalog card for each document. Different workgroups can be assigned to one of 26 different sections in the library. A workgroup can be assigned to its own catalog and section, or many workgroups can be assigned to the same catalog and section.

Each catalog card comprises two screens. The first contains identifying information for the document, including title, author, department, operator, client, matter, comments, and keywords. The second screen contains document statistics such as date created, last access date, last user, number of revisions kept, archive interval, chargeback method and statistics for billing clients (including the actual and charged number of keystrokes), pages printed, and time. Most of the field descriptions can be customized (see photo 1).

Once a catalog card has been created, ProFound can perform searches on 18 different fields, including indexed fields such as author, department, date, client, and matter, and on user-definable keywords. You can use both range and Boolean search parameters to find any documents that have been checked into ProFound. ProFound also does full-text indexing and searching.

Documents that match your search request can be previewed in the library, copied to a new document in your work area, or checked out for modification. You can store document templates in ProFound, but inexperienced users would benefit from having these set up by their system administrator.

ProFound automatically maintains an audit trail of activity for each document, and it can maintain up to 99 revisions of each document. Most users will maintain only a few revisions and will save disk space by archiving their older revisions. You can configure ProFound to automatically back up files to specified directories and to automatically archive files after a predetermined number of days, if the files have not been checked out for that period of time.

Access to documents is controlled through the use of passwords, which can be assigned for each operator, author,

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BYTE LAB

ProFound

Company
Wang Informatics Legal & Professional Systems
2111 East Highland, Suite 400
Phoenix, AZ 85016
(602) 224-0855

Hardware Needed
IBM XT, AT, PS/2, or compatible with 640K bytes of RAM and a hard disk drive with at least 2 MB of storage

Software Needed
DOS 3.1 or higher and Novell NetWare 2.15 or 386; Banyan VINES 3.1 or higher; or 3Com 3Share network operating system

Price
First five users: $995

Inquiry 1076.

Imara

Company
Imara Research Corp.
111 Peter St., Suite 804
Toronto, Ontario
Canada M5V 2H1
(416) 581-1740

Hardware Needed
Intel 386SX-, 386-, or i486-based workstations with 4 MB of RAM and VGA; HP ScanJet; HP LaserJet; GammaLink's GammaFax adapter; 30-MB hard disk drive; network server with 8 MB of RAM and 100-MB hard disk drive or optical disk storage

Software Needed
OS/2 1.2; OS/2-compatible network operating system; network-based SQL database server

Price
First two users: $2995

Inquiry 1077.

department, or document. Users can be assigned access or modification rights to any or all documents in the system.

ProFound uses a WordPerfect-like interface with pull-down menus, pop-up windows, on-line context-sensitive help, and lots of command keys. ProFound is easy for experienced WordPerfect users to learn and is relatively easy to set up.

The system administrator guide is clearly organized and uses a step-by-step approach. However, the guide does not provide a top-down view of how the program's modules interact. It is best to simply read the system administrator guide cover-to-cover before setting up the program.

As with many database programs, interdependent modules eliminate any hope of shortcuts. Network administrators should plan to spend some time determining the most efficient way to set up ProFound's library and to distribute their workgroup's documents across their network's servers. Once ProFound has been set up, however, its on-screen prompting should enable experienced word processors to master ProFound in an hour or two.

ProFound has been integrated with WordPerfect 5.1 and Jurisoft's CompareRite. If you are using WordPerfect, the ProFound interface takes over when you create, load, or save a document. When you save documents, ProFound's Integrated Document Card Screen is displayed, enabling you to check your document into ProFound without leaving the WordPerfect interface. If Jurisoft's CompareRite has been installed, past revisions can be red-lined from inside ProFound.

Although ProFound is designed to work with any office workgroup, its most obvious audience is professional offices that do time or project billing. ProFound automatically records keystrokes, time spent in each document, and the number of pages that have been printed. This information is displayed on each document's catalog card and can be printed in a disbursement report. Charges can be accrued on a straight time basis or on a per-document basis. After the clients have been entered into ProFound's client section, ProFound automatically verifies that documents belong to a specific client and generates a disbursement charge report that can be exported into several time-billing programs.

ProFound requires an IBM XT, AT, PS/2, or compatible with 640K bytes of RAM and a hard disk drive with at least 2 MB of storage. The program runs on DOS 3.1 or higher and supports Novell Advanced NetWare 2.15 or higher, NetWare 386, or Banyan VINES 3.1 or higher.

Imara Imaging

Imara uses a client-server architecture built on Microsoft's OS/2-based SQL Server. Once you have stored documents

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FAX: (407) 260-5366

Circle 116 on Reader Service Card (RESELLERS: 117)

in Imara as compressed Group 4 fax images, you can share them within a PC-network environment.

Imara uses a five-level hierarchical cataloging system. Users define their image database by creating *sets*, which are analogous to file cabinets; *categories*, which are like file drawers; and *file folders*, which contain *documents*. Documents are composed of one or more image and text *pages*. Imara's database can store up to 40 million pages. Once documents have been stored in Imara's database, you can access them through Imara's query-by-forms and keyword search facilities.

After categories have been set up, you can fill in a form template for each document you wish to check in. These templates are similar to ProFound's catalog cards and enable you to search for documents using structured information, such as owner, topic, action-due-date, and priority, and to perform unstructured searches using keywords that cross-reference information in different files.

Individual pages can be retrieved and displayed at the user's workstation and can be annotated with electronic MemoTabs. MemoTabs are electronic notes that provide a convenient way to share comments about a particular image. They can be either displayed on the image or hidden to facilitate printing.

Users create their filing system by creating new sets, categories, and folders interactively with Imara, or by using Imara's Execution Language (IXL) to create a database script. If you will be moving many documents into Imara, it is much faster to create a database using IXL than to create the database as you import your files.

Imara's script language is straightforward—Imara has done a good job of protecting the user from the SQL Server interface. But the documentation assumes that the system administrator has a thorough understanding of SQL Server and of the networking environment.

When you start Imara, you see four icons: a server, an in box, an out box, and a trash can. The server icon includes all the document and image files that have been stored in different sets, categories, and file folders. The in box lets you scan or fax graphics files and import ASCII text files into the system. The out box lets you fax, print, export, or I-mail files. The trash can lets you delete or remove files (see photo 2).

When you first click on a page in a document, two windows appear: a page tool and a page window. The page window displays a portion of the image file that you have loaded into the Imara desktop. The page tool's Panview displays a miniature of the entire page, along with a shaded rectangular area called the *lens*. The area in the lens indicates the specific portion of the page. By dragging the lens in the page tool with your mouse, you can view different parts of your image file in the page window. Imara also has a preview feature that lets you view an image without loading and decompressing it.

Imara's I-mail lets you distribute documents by copying or linking them to other folders. I-mail is too limited for general office messaging, however; it only provides a one-line message field.

Much of Imara's power comes from its ability to link documents. Linking documents assigns pointers from a document to different file folders. This helps conserve disk storage and allows users working within different file folders to view

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or modify multiple copies of a document.

Imara's use of Group 4 file compression enables you to store 8½-inch by 11-inch 300-dot-per-inch images, which normally require about 3 MB of storage, in several hundred kilobytes. But Group 4 compression doesn't work well with complex images like photographs; in fact, this type of image may be larger after compression. But the bottom line, according to Imara, is that storage costs using "jukebox" optical drives have come down to about 5 cents per page—provided you make the initial investment in such equipment. This is competitive with microfilm and paper-based document storage systems.

I found that 150-dpi scanned or faxed images are hard to read on a standard 14-inch VGA monitor. Using a 1024- by 768-pixel enhanced VGA display or a 1280- by 960-pixel 19-inch Moniterm display greatly enhances document legibility and obviates the need to print out as many files. Since Imara currently supports only monochrome displays and printers, most users will opt for a large high-resolution monochrome display.

Imara has written its own OS/2 driver to support the HP ScanJet Plus, and the company recommends GammaLink's GammaFax. (At press time, GammaLink was the only fax-modem supplier shipping an OS/2 driver.)

Imara's ScanJet interface works flawlessly, but I discovered that Hewlett-Packard's interface card conflicts with 16-bit VGA cards. (This can be resolved by plugging 16-bit VGA cards into an 8-bit slot.) Scanning images requires patience; most users will eventually be compelled to invest in an automatic document feeder for their scanner.

All this power takes its toll in the hardware department. Imara workstations require at least a 386SX-based PC with 4 MB of RAM, a 30-MB hard disk drive, a VGA adapter and monitor, a mouse, and a network adapter running OS/2 1.2 or higher.

Imara servers require a 386 processor with at least 8 MB of RAM, a 100-MB hard disk drive, and a network operating system that supports OS/2 1.2 with Microsoft SQL Server 1.1, Oracle Server, or IBM's Database Manager.

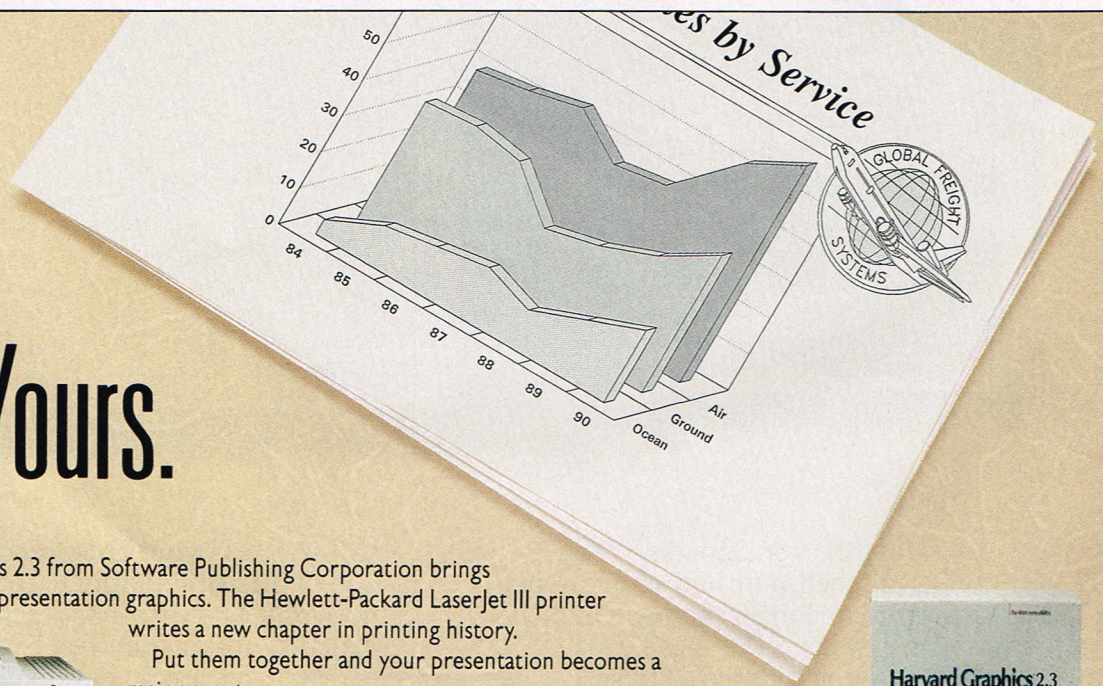
Imara recommends using WORM (write once, read many times) optical disk storage, HP LaserJet printers with at least 2 MB of memory, GammaLink's GammaFax, a LaserMaster LXI printer controller (to enable the LaserJet to print images at a usable speed), and an HP ScanJet Plus.

Management Decisions

Both Imara and ProFound solve real-world document management problems. But despite their implementation of advanced client-server technologies, neither product lets users manage both text and image files effectively.

Businesses such as law firms and accounting firms that have standardized on particular DOS applications like WordPerfect or Lotus 1-2-3 should give ProFound careful consideration. Businesses such as insurance companies managing many graphics-based documents that include diagrams, hand-written notes, and signatures will find Imara invaluable. ■

Doug Dayton is the founder of Dayton Associates, a computer-industry marketing and consulting firm in Bellevue, Washington. He can be reached on BIX c/o "editors."



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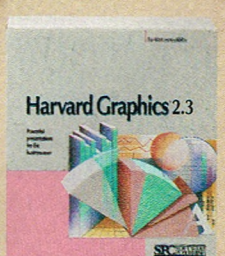


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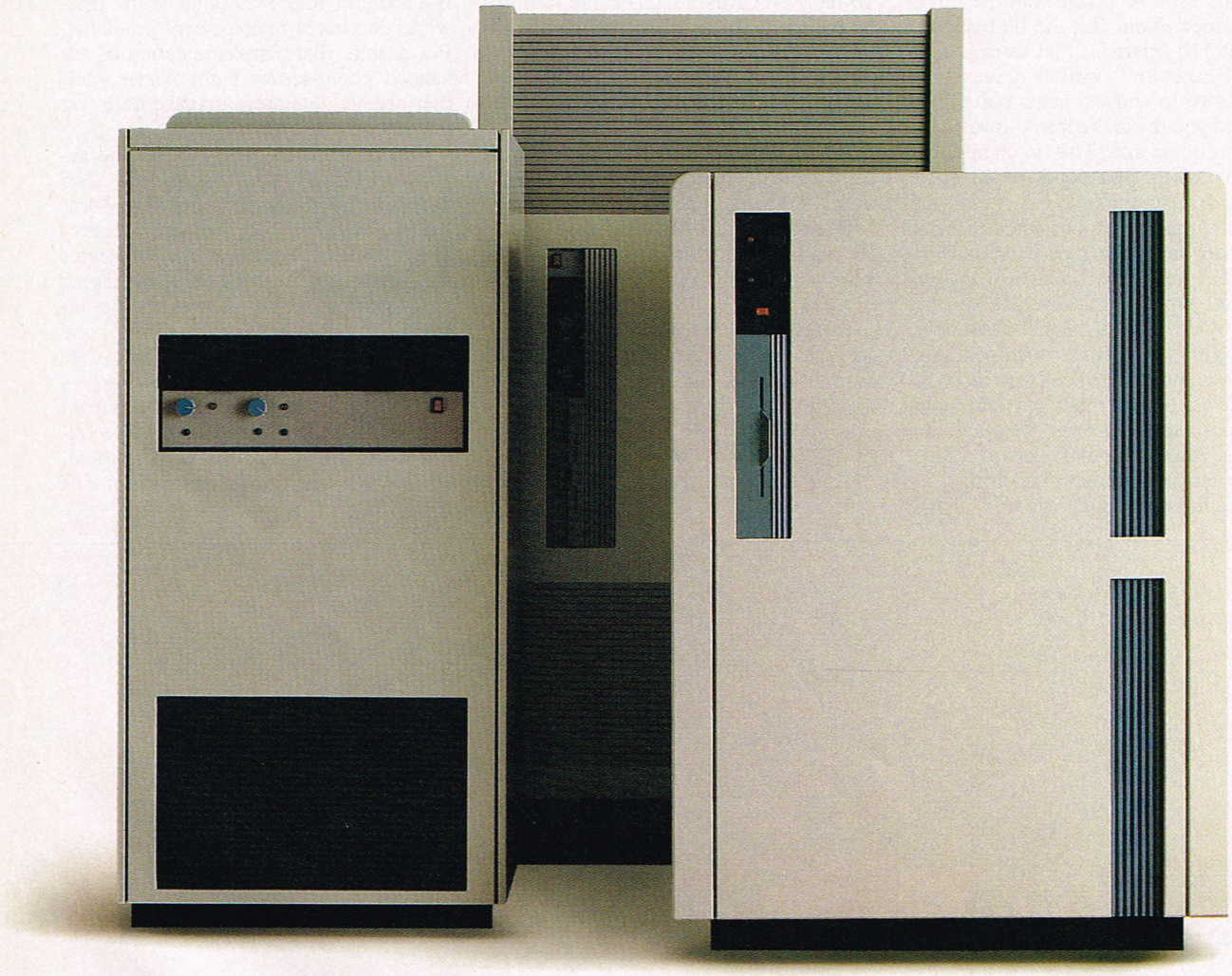


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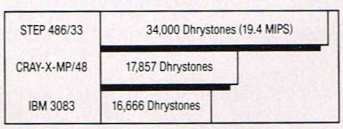
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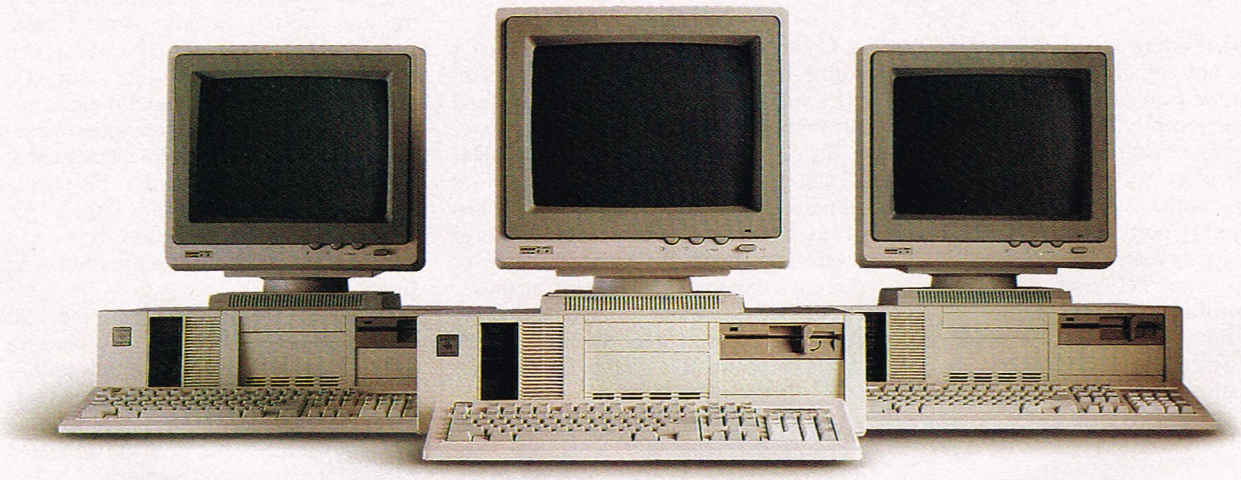
There are two reasons. The first, of course, is the 486™ chip. The other is AMMA,™ Everex's proprietary Advanced Memory Management Architecture.

AMMA uses "write-back" cache technology instead of the "write-through" technologies used in most PC's. The write-back cache was developed for mainframes. Everex was the pioneer in developing it for the PC. And in doing so, opened a whole new dimension in desktop performance.

With AMMA, you can write directly to the STEP 486's cache in nearly all cases. With write-through techniques, on the other hand, you lose most of the performance benefit of the cache.

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And how to keep up with them.



That's because write-through forces you to write to main memory much more often. And main memory is slower than the cache.

This is especially important in 486 computing, where the CPU performs as many as four times the write operations as in 386. Which makes AMMA's write-back architecture, combined with the 486's embedded cache, a powerful combination indeed.

But the STEP 486 machines give you more than just speed. They come with Programmable Drive Select. If your drive isn't listed on the set-up table, PDS™ lets you custom-configure the BIOS. It's good for virtually any hard drive.

What's more, all STEP systems come with a one-year extendable warranty and a one year renewable on-site service contract that also covers all Everex peripherals in the system.

To find out more, call 1-800-334-4552* for the name of your nearest Authorized Everex Reseller—every one a high performance expert.

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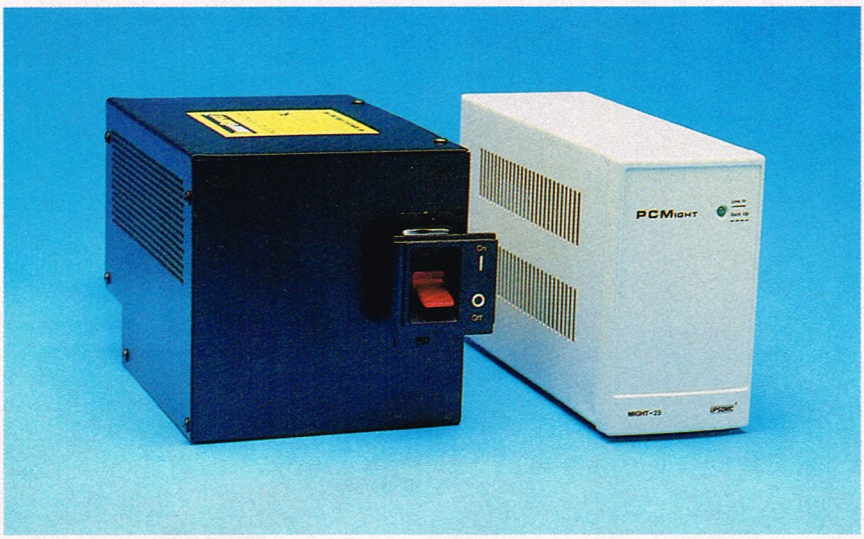
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Steve Apiki

REVIEW

Small, Low-Cost UPSes



PC Power's InnerSource 2210 (left) takes a unique approach to backup power by offering a UPS as a replacement for a standard supply. Upsonic's PC Might-25 (right), a single-user UPS, is the smallest, lightest unit BYTE has seen.

Data residing on a single-user system is not any less critical than data stowed on a network file server. But until recently, protecting your single-machine installation from the vagaries of your utility company often meant shelling out the cash for a big, noisy uninterruptible power supply (UPS) with more capacity than you required.

Upsonic and PC Power & Cooling offer two solutions to the problem of supplying reliable power to a single machine. The Upsonic PC Might-25 is a small, quiet, and inexpensive UPS that's suitable for use on a desktop. PC Power & Cooling's InnerSource Model 2210 is a drop-in replacement for AT power supplies with an internal standby system and AC power for the monitor.

Strictly speaking, both the PC Might-25 and the AC side of the InnerSource are standby power supplies (SPSes). When utility power fails or dips below a critical level, they switch from providing power directly from the line to providing power from a built-in battery. When there is adequate AC power, they use some of the available energy to recharge the battery.

While these two models are functionally similar, their design philosophies are radically different. The PC Might-25, although small and inexpensive, is more or less a traditional SPS; the InnerSource, on the other hand, avoids many of the problems of providing AC backup by supplying DC power directly to the computer.

PC Might-25

At $195, the PC Might-25 is easily the least expensive SPS I have come across. The price is low enough to attract people who may never have considered buying an SPS in the past. What you get won't shatter any records for holdup time or provide the same type of power your system's power supply is used to, but it will provide adequate power for conducting an orderly shutdown.

The unit is not much bigger than a large modem or a small external disk drive. Installation is simple. The nine-page user's manual is enough to describe user interaction with the system in sufficient detail.

As you might expect from the unit's size, holdup time is limited. The PC Might-25 shuts off before the battery is completely drained, to lengthen battery life and shorten recharge time. I measured holdup time with two loads. The first was a small 286 system running a hard disk drive and a monochrome monitor; this system drew 0.8 amperes of current, so the power requirement was about 40 percent of the PC Might-25's capacity. The second load was a larger 486-with-VGA unit that drew close to twice as much power. The results are shown in figure 1.

When the power goes off, the unit sounds a noticeable but unobtrusive alarm. That's its only communication—since it is meant to back up single systems, the unit has no ports for sending signals over a network or to the protected system for automated shutdown.

Small capacity offers one small advantage: It takes very little time to recharge the unit. Upsonic claims that a full recharge can be completed in 2 to 3 hours.

I had no problems running systems during standby operation. The manufacturer specifies transfer time (the time to switch from normal to backup power) at 4 milliseconds, which should be quick enough to escape the computer's notice. Cut-in and cut-out points are fixed at 102 volts and 108 V, respectively, so if you experience frequent brownouts, the system may go on and off more than you would like.

Backup power has a modified square waveform. Engineers argue over whether

PC Might-25

Company
Upsonic Corp.
One Park Plaza, Suite 600
Irvine, CA 92714
(714) 833-7162

Hardware Needed
Microcomputer system
(drawing 250 VA or less)

Price
$195

Inquiry 1106.

InnerSource Model 2210

Company
PC Power & Cooling, Inc.
31510 Mountain Way
Bonsall, CA 92003
(619) 723-0075

Hardware Needed
AT or 386 computer with space for a full-size (8⅝- × 5⁹⁄₁₀- × 5⁹⁄₁₀-inch) power supply

Price
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Inquiry 1107.

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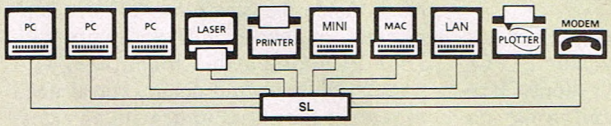
New Model – SLP™ has 8 parallel and 2 serial ports: The original SL™ has 4 parallel and 6 serial ports. Both can share any combination of ten printers or PCs; automatic switching, queuing, and serial-to-parallel conversion

Improved Data Throughput – True 115,200 bps: use other vendors' file transfer software with serial connected PCs

Pop-up Menu via Hotkeys: Keyboard selection of printers

Simple Installation: Just plug in your cables and run the menu-driven installation software

User Upgradable Memory: From 256KB to 4MB buffer



Save by Sharing Resources: The SL enables everyone to share lasers, printers, plotters, and modems. Greater access by more users reduces unproductive idle time and the expense of purchasing additional peripherals. All users can simultaneously send print data and quickly release their PCs to continue working.



HWP — 5 Ports from $275

All ports are parallel and user configurable as either 3 inputs to 2 outputs with a pop-up menu, or 4 inputs to 1 output as a buffered auto-switch; memory is user upgradable from 256KB to 16MB buffer

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4 parallel inputs to 1 parallel output, automatic switch with no buffer; use the AS-31 for up to 3 inputs to 1 output, $175

CE — 2 Ports from $175

Printer buffer with 1 parallel input to 1parallel output, from 256KB to 4MB buffer

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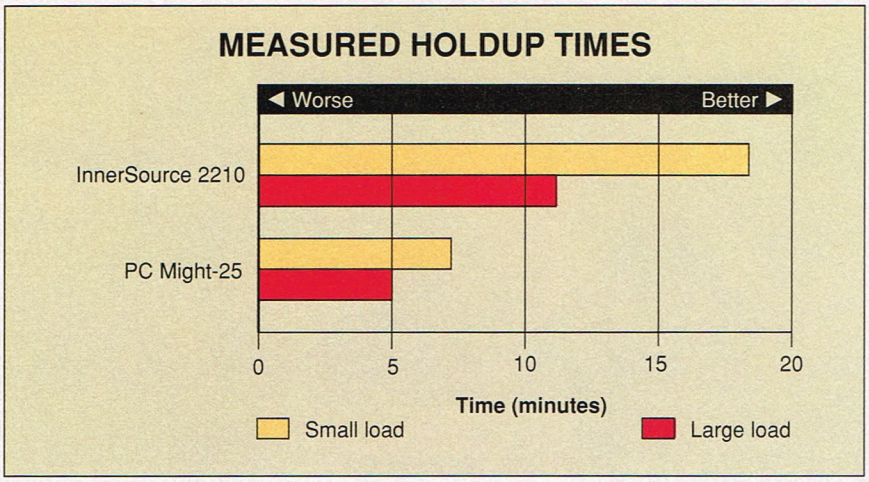


Figure 1: *Holdup times for typical small and large loads, in minutes.*

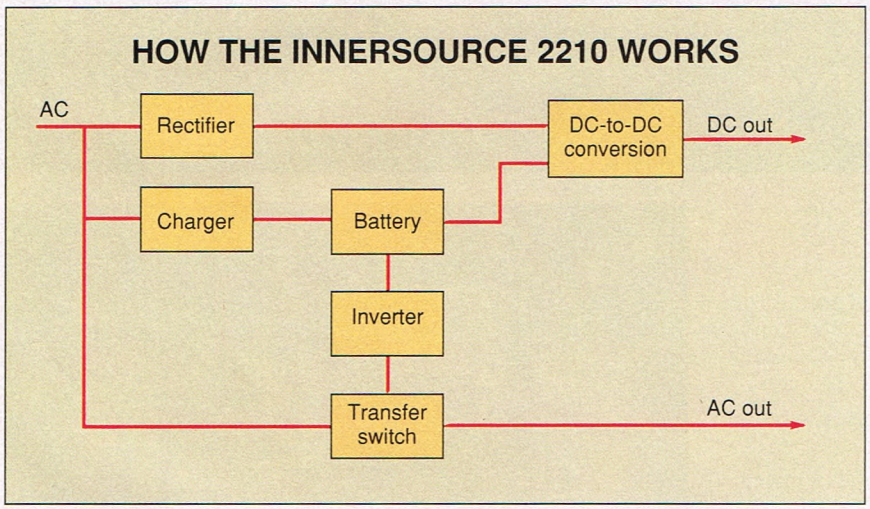


Figure 2: *Block diagram of the InnerSource 2210 power supply. The output of the battery is wired to the DC-to-DC converter, which means that no DC switching is required when power fails.*

or not square waves make a good input to switching power supplies, but the PC Might-25 provides output filtering to eliminate much of the noise associated with square-wave outputs.

The InnerSource

A traditional SPS takes in AC power, converts it to DC power, and stores it in a battery. When a blackout occurs, the unit takes DC power from the battery, transforms it to AC power, and sends it to the power supply in the computer, which transforms it to DC power for use in the system. For those of you keeping score, that's three conversions where only one is required, and each conversion means less efficient use of power.

PC Power & Cooling's InnerSource eliminates most of the extra steps. The InnerSource looks (and acts, under normal conditions) like a standard, FCC Class B, full-size AT power supply. It replaces the power supply unit in the machine that you intend to protect. When the power fails, the unit supplies DC power from the battery directly to the system board (see figure 2). There is no need for additional conversion.

In addition to having a clean and efficient design, the InnerSource sidesteps debates over which waveform is best and how much noise an AC inverter introduces. Since the battery and rectifier are connected to the same transformer, PC Power & Cooling also claims zero transfer time between standby and normal operation.

If you didn't need to power a monitor during a blackout, this would be the end of the story. Since you do, the InnerSource provides a standard battery-inverter stage for supplying AC power to the system monitor. This is a typical standby system, with a rated transfer time of 2 ms and a 120-V root mean square modified rectangular-wave output.

Holdup times, shown in figure 1, were good—certainly enough to save work and shut down properly. Like the PC Might-25, the InnerSource sounds an alarm at power failure and shuts down before the battery is completely drained. This unit requires 8 hours for a full recharge, but it recharges constantly as long as the system is plugged in.

Classifying the power output of the InnerSource is not as easy as it is with that of an external SPS. The unit supplies 220 watts of DC power to the system board and 120 volt-amperes of AC power to the monitor. With efficiency and power-factor calculations considered, PC Power & Cooling claims that the InnerSource is equivalent to a 550-VA external UPS; in any case, 220 W is enough to run a heavily stocked AT or 386 system with no problems.

The 120-VA (1-amp) AC source, however, is a little underpowered. Typical VGA monitors require just about all of this; an IBM 8513, for example, requires 0.95 amp. Big-screen monitors can easily require 1.2 amp and may require 1.6 amp; the power draw means you can't use the InnerSource with a typical 19- or 20-inch monitor.

If you want to run a network server off the InnerSource, PC Power & Cooling offers a $49 module that lets the InnerSource talk to a network.

The InnerSource has a few weak spots, but these have to do with the nature of the device. It requires enough room inside the case for a full-size supply and, of course, will work only with IBM PC–compatible machines. If a power failure should occur, you'll need to replace the entire unit; with an external system, you need replace only the UPS or the internal supply. And at $495, replacements aren't cheap. Fortunately, PC Power & Cooling has an excellent reputation for reliability.

Between the PC Might-25 and the InnerSource, you should be able to find what you need to back up a single system. Whether you prefer the traditional external device or the drop-in replacement concept, the peace of mind you'll get is worth the small investment. ■

Steve Apiki is a BYTE Lab testing editor/engineer. He can be reached on BIX as "apiki."

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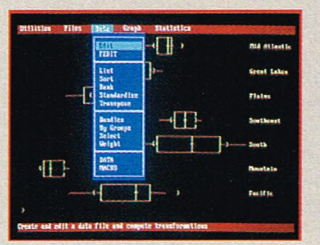
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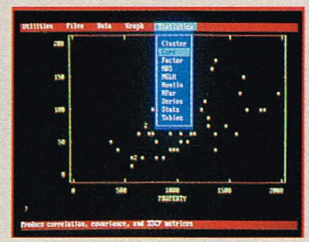
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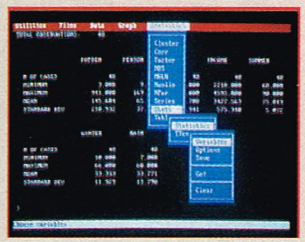
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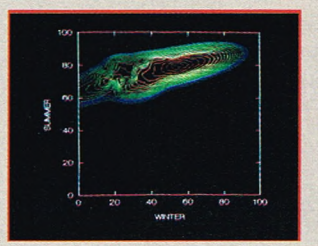
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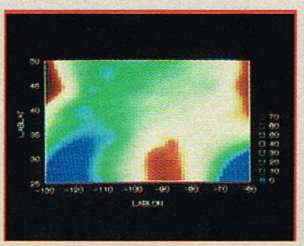


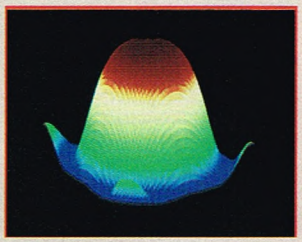












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Statistics Basic statistics, frequencies, *t*-tests, post-hoc tests ▮ Multi way crosstabs with log-linear modeling, association coefficients, PRE statistics, Mantel-Haenszel, asymptotic standard errors ▮ Nonparametric statistics (sign, runs, Wilcoxon, Kruskal-Wallis, Friedman two-way ANOVA, Mann-Whitney U, Kolmogorov-Smirnov, Lilliefors, Kendall coefficient of concordance) ▮ Pairwise/listwise deletion of missing values, Pearson correlation, SSCP, covariance, Spearman, Gamma, Kendall Tau, Euclidean distances, binary similarities ▮ Linear, polynomial, multiple, stepwise, weighted regression with extended diagnostics ▮ Multivariate general linear model includes multi way ANOVA, ANCOVA, MANOVA, repeated measures, canonical correlation ▮ Principal components, factor analysis, rotations, components scores ▮ Multidimensional scaling ▮ Multiple and canonical discriminant analysis, Bayesian classification ▮ Cluster analysis (hierarchical, single, average, complete, median, centroid linkage, k-means, cases, variables) ▮ Time series (smoothers, exponential smoothing, seasonal and nonseasonal ARIMA, ACF, PACF, CCF, transformations, Fourier analysis) ▮ Nonlinear estimation (nonlinear regression, maximum likelihood estimation, and more).

Graphics Overlay plots ▮ Drivers for most graphics devices ▮ *Two-dimensional:* Error bars ▮ Scatterplots ▮ Line and vector graphs ▮ Vector, dot, bubble and quantile plots ▮ Bar graphs (single, multiple, stacked, range) ▮ Box plots (single and grouped) ▮ Stem-and-leaf diagrams ▮ Linear, quadratic, step, spline, polynomial, LOWESS, exponential smoothing ▮ Confidence intervals and ellipses (any alpha value) ▮ Smooth mathematical functions ▮ Rectangular or polar coordinates ▮ Log and power scales ▮ ANOVA interaction plots ▮ Histograms (regular, cumulative, fuzzy) ▮ Stripe and jitter plots ▮ Gaussian histogram smoothing ▮ Scatterplot matrices ▮ Voronoi tesselations ▮ Minimum spanning tree ▮ Maps with geographic projections (U.S. state boundary file included, county and world boundary files available) ▮ Chernoff faces ▮ Star plots ▮ Fourier plots ▮ Pie charts ▮ Contour plots on regularly and irregularly spaced points ▮ Control charts and limits ▮ *Three-dimensional:* Data plots ▮ Smooth function plots ▮ Vector plots ▮ Linear, quadratic, spline, least squares surface smoothing ▮ Typefaces that print in perspective.

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Circle 333 on Reader Service Card

Michael Nadeau

REVIEW

TravelMate 2000 Lives Up to Its Name



The Texas Instruments TravelMate 2000 packs AT-class performance into a 4-pound notebook PC.

TravelMate 2000

Company
Texas Instruments
P.O. Box 202230
Austin, TX 78720
(800) 527-3500

Components (as reviewed)
Processor: 12-MHz 80C286; socket for 80C287 math coprocessor
Memory: 1 MB of RAM; 1 MB of ROM for MS-DOS 4.01 and utilities
Mass storage: 2½-inch 23-ms 20-MB Conner Peripherals hard disk drive
Display: 10-inch-diagonal 640- by 480-pixel VGA; backlit triple supertwist LCD
Keyboard: 79-key IBM Enhanced style
I/O interfaces: One parallel port; one serial port; one proprietary external expansion bus

Size
11 × 8½ × 1⅘ inches; 4⅘ pounds (with battery)

Price
$3995

Inquiry 1078.

There's something about the Texas Instruments (TI) TravelMate 2000 notebook PC that says, "Take me with you." Its size (11 by 8½ by 1⅘ inches) and weight (4⅘ pounds with battery) are big factors in creating that impression. So are its 640- by 480-pixel VGA display, internal 20-megabyte hard disk drive, and 12-MHz 80C286 CPU. Together, these features make for what is arguably the most totable AT-class notebook system available.

The TravelMate 2000 has its flaws. The battery life is sub-par: 2 hours at best (an optional battery pack adds 3 hours to the running time, 2⅓ inches to the length, and about 2 pounds to the unit's weight). A floppy disk drive is available only as an external option. Some people might find the keyboard uncomfortable to use; the keyboard presents no typing angle to speak of, and it's set back about an inch from the front of the unit. And with a price of $3995, the TravelMate is also expensive.

On the plus side, the TravelMate provides performance, VGA, and convenience. These benefits compensate for the drawbacks if portability is the main issue.

What You Get

TI sells the standard TravelMate with 1 MB of internal RAM (expandable to 3 MB with two 1-MB RAM cards), a 2½-inch 23-millisecond 20-MB hard disk drive, one serial and one parallel port, the triple supertwist VGA LCD screen with 16 gray levels, and an AC adapter. MS-DOS 4.01, LapLink, and the system utilities reside on 1 MB of ROM. This all fits easily into any briefcase, with room left for other essentials.

When you turn on the TravelMate, you are greeted by Laptop Manager, a DOS shell. Laptop Manager comes set up to run the system utilities from a menu; adding applications to the menu is a simple matter of answering a few prompts. If you get stuck, pressing F1 brings up a help screen.

The system utilities include Traveling Software's ubiquitous LapLink file transfer program (cables are included with the TravelMate) and Battery Watch, which monitors battery drain. Both programs are well-regarded, time-tested utilities.

TI pairs Battery Watch with its BatteryPro power-conservation software. BatteryPro is what TI terms a "power conservation system." Basically, it monitors the notebook's components—hard disk drive, display, and keyboard—and shuts them down when they're not used for a specific amount of time. It puts the whole system in standby mode after a period of inactivity, and it automatically selects CPU speed for your applications. (The slower you run the CPU, the less drain on the battery.) It also has a RAM-based hard disk cache to minimize accesses. Power utilities of this ilk are becoming common on many notebook PCs.

Despite BatteryPro's energy-saving features, the TravelMate manages only 2 hours of running time on a charge. This is undoubtedly because TI shaved size and capacity from the battery to reach size and weight goals.

File Manager, another Laptop Manager utility, is exactly what its name implies; you can edit, execute, copy, delete, find, and so on. File Manager is simple and does the job, but it's no Norton Commander. For instance, if you want to find a file, you must already be in the directory in which it resides.

Options You Will Need

If you spend $4000 for a 4-pound AT-compatible system, you will probably want all the benefits of the 12-MHz processor along with its convenience. Well, you can have them, but at the cost of a few more dollars and a little of that convenience.

For starters, you need a modem (it's about time modems became standard equipment on all notebook PCs) and at least another megabyte of memory to run the latest software. Add $499 and $549,

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- 16-bit VGA card w/512K
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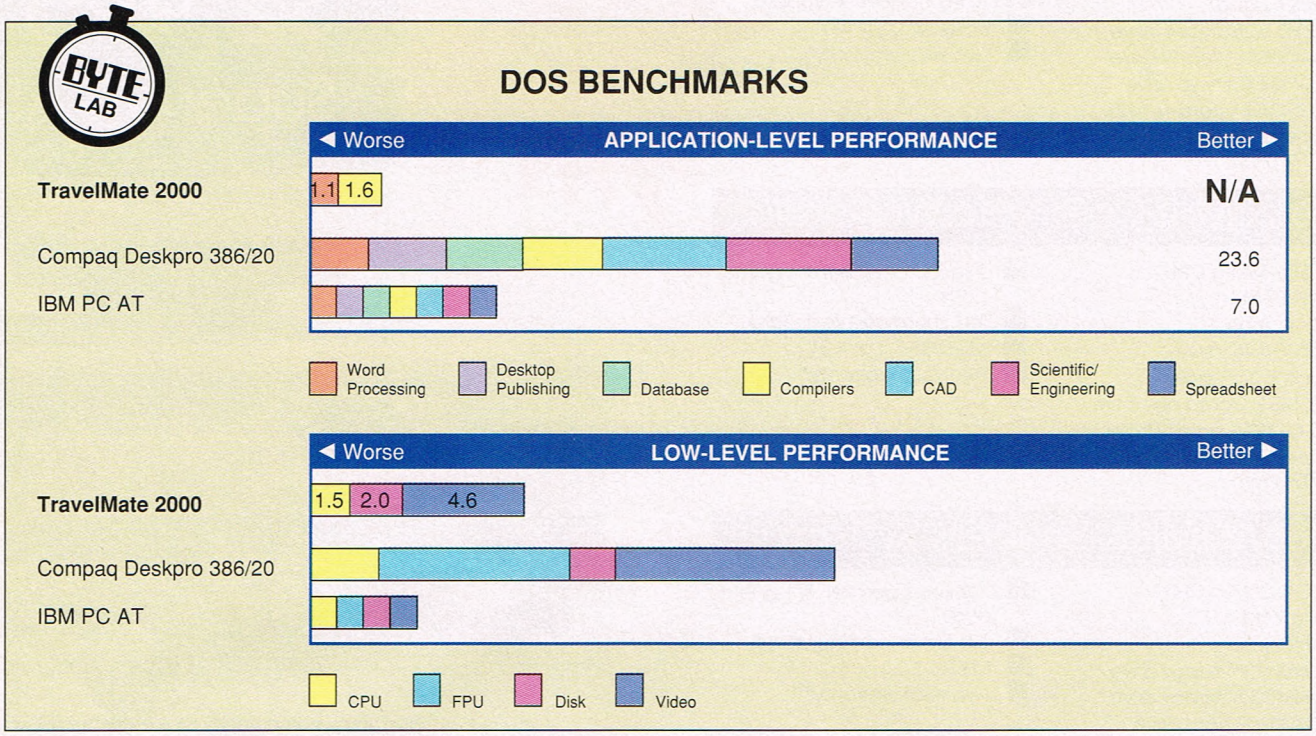


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Compaq 386/20	0.16970	8449.7
IBM PC AT	0.02105	2317.9

For application and low-level benchmarks, results are indexed and show relative performance; for each individual index, an 8-MHz IBM PC AT running MS-DOS 3.30 = 1.

The BYTE low-level benchmark suite identifies performance differences between machines at the hardware level; the application benchmarks evaluate real-world performance by running a standard test suite using commercially available applications. Application indexes include tests using the following programs: Word processing: WordPerfect 5.0; Desktop Publishing: Aldus PageMaker 3.0; Database: Borland Paradox 3.0 and Ashton-Tate dBASE IV; Compilers: Microsoft C 5.1 and Turbo Pascal 5.5; CAD: AutoCAD release 10 and Generic CADD level 3 1.1.5; Scientific/Engineering: Stata release 2, MathCAD 2.5, and PC-Matlab 3.5f; and Spreadsheet: Lotus 1-2-3 release 3.0 and Microsoft Excel 2.1.

The BYTE Lab introduced version 2.0 of the DOS benchmarks in the August issue (see "BYTE's New Benchmarks: New Looks, New Numbers"). Benchmark results for machines reviewed under previous versions aren't directly comparable. To obtain a copy of the benchmarks, join the listings area of the byte.bmarks conference on BIX or contact BYTE directly.

respectively. If you use Windows or another graphical user interface, you will want the full 3 MB. And you will want the second battery pack ($249), or at least a spare internal battery ($129). Two hours is barely enough under the best circumstances. I got between 1½ and a little under 2 hours.

These options push your capital investment to over $5000. You also end up with about 2⅓ pounds more than the 5 pounds (with AC adapter) that you were already carrying. With the added paraphernalia, you also might have to make more room in your briefcase.

Other Observations

Although I complained about it earlier, I find the TravelMate's keyboard acceptable in light of what TI is trying to accomplish. It felt comfortable, and I had little trouble adjusting to it.

Cradling it in your arm, the TravelMate has a solid feel. It runs quietly; I did not experience the high-pitched whine some LCDs emit. I did notice something about the construction that troubled me: When you open the screen, the tension from the hinge flexes the plastic above the keyboard more than I'm comfortable with. I don't think this will affect the electronics, but I do worry about stress cracks developing in the case.

On the BYTE benchmarks, the TravelMate turned in scores that, while not startling, were at least respectable—particularly in the disk and video tests. Unfortunately, the BYTE Lab could not get a cumulative application index, as the notebook's memory configuration was inadequate for running some of the software used in that test suite. My evaluation unit was not equipped with a math coprocessor.

The black-on-white VGA screen has good contrast, and the light seems well diffused. A switch lets you reverse the video to white-on-black, and the contrast and brightness controls have adequate range. A pop-up utility lets you adjust the gray scaling.

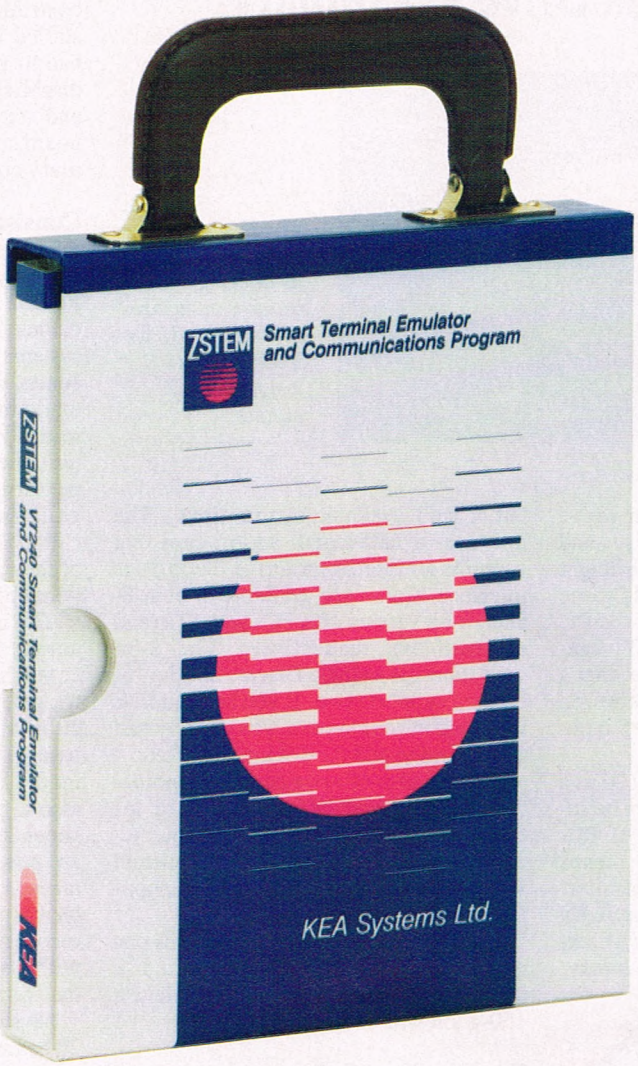
The Verdict

TI has quite an accomplishment in the TravelMate. For many people, it is incomplete in its standard form, but no other computer offers so much in just 4 pounds. (The Sharp 6220 is the same computer with only cosmetic differences and no utility software. TI makes it and similar notebook PCs under OEM arrangements. The TravelMate was actually a joint design project with Sharp.)

The TravelMate is a charmer, warts notwithstanding, and that charm is proportional to the weight of the portable you are currently lugging around. The ultimate portable is one that you don't notice carrying and that performs comparably to your desktop system. The TravelMate is as close as you can get to that ultimate portable. TI sacrificed some functionality to get there, but the trade-offs are reasonable. ■

Michael Nadeau is the managing editor of the BYTE Lab. You can reach him on BIX as "miken."

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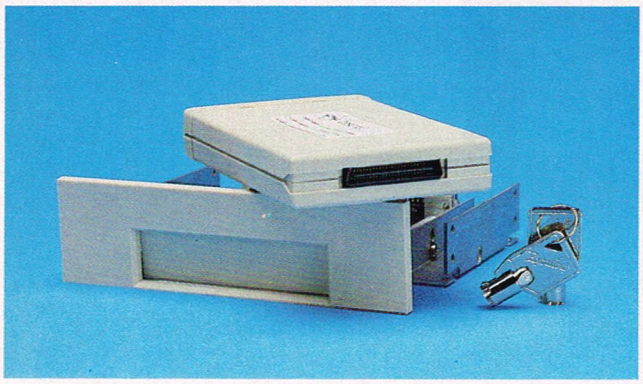
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Circle 194 on Reader Service Card

Stan Miastkowski

REVIEW

Pricey Hard Disk Drive Portability



The Disctec 20, shown here with its docking bracket, measures just 3.2 by .81 by 5 inches and weighs only 7 ounces.

The Disctec 20 shows how far we've come from the clunky, noisy, and notoriously short-lived full-height hard disk drives that were the only game in town during the early days of the PC revolution. The Disctec 20 is a 20-megabyte removable hard disk drive that's packaged in a neat little nylon-covered case measuring just 3.2 by .81 by 5 inches. It weighs a scant 7 ounces.

You might describe the Disctec 20 as a thick floppy disk. It's designed to be interchanged with a wide variety of PC-compatible computer systems by means of a "docking bracket" and a controller. The standard docking bracket requires a half-height bay in your system. (An external docking bracket would be handy, but it isn't available at this time.) The unit uses a half-length add-in card that contains an Intelligent Drive Electronics interface. Cards are available in both 8- and 16-bit versions for PCs and ATs (and compatibles), respectively. The 8-bit card supports a single Disctec 20; the 16-bit card supports two. If you have an IDE interface in your system, you can buy just the cartridge and the docking bracket.

Disctec also offers a custom combination docking bracket/interface card for the Toshiba T1200's expansion slot. According to the company, more custom versions are in the works for other popular laptop systems.

The case is well sealed and houses one of the new-generation 2½-inch hard disk drives. The company claims it will take a 150-g jolt without damage.

For Your Eyes Only

The idea of a portable, removable hard disk drive isn't a new one (Tandon did it years ago), but Disctec is the first company to make it truly handy. The disk cartridge itself is small and light enough to toss into your briefcase at the end of the day and bring home to another computer equipped with a docking bracket. Even better is the ability to easily tote your work along on the road with a Disctec 20 in a laptop. And of course, you can't overlook the security aspect. If you lock up your Disctec cartridge or (even better) take it along, your data is absolutely secure from prying eyes. And if you use the Disctec 20 as your boot device, your computer's even more secure.

Installing the Disctec 20 isn't complicated. I installed mine in a 20-MHz 386 system in two different configurations: as the primary (boot) drive and as a secondary hard disk drive. The Disctec controller also has a floppy disk drive interface, so it can be the only disk drive controller in your system. When I installed it as the secondary controller, I had to play with jumpers on the board, disabling the floppy disk drive controller and setting the memory location for the board so it wouldn't conflict with the primary controller.

Consistent Performer

The Disctec 20 requires special driver software, called from your DOS CONFIG.SYS file. Unfortunately, that precludes its use with alternative operating systems, such as OS/2. The software comes with its own well-designed automatic installation utility. That's where I initially ran into trouble. After installation, the Disctec 20 was flaky, and disk-performance utilities such as Norton Utilities refused to recognize it. A quick call to Disctec got me an updated version of the driver, and I didn't have any additional problems after that.

The installation utility lets you choose among several options, including whether you hear a beep when you change cartridges. And if you're using the Disctec 20 in a laptop, you can choose the time before the drive goes into a "spin-down" mode to conserve battery power. There's also a power-save mode where the disk keeps spinning but the support circuits are powered off. In spin-down mode, it takes about 2 seconds for the drive to get back up to speed. In power-save mode, recovery takes a short $^1/_{10}$ second. Even without the power-conserving modes, the Disctec 20 pulls just 1 watt of power.

No slouch at performance, the Disctec 20 has an average access time of 23 milliseconds, according to the company. The unit I tested did better, consistently scoring in the 19- to 20-ms range. Data transfer is a respectable 500 megabits per second. There is no performance penalty in using the Disctec 20. In fact, it was considerably faster than my primary drive.

The Disctec 20 is well built and handy. But you'll pay a large premium for convenience. The interface, docking bracket, and a cartridge retail for $670 to $695, depending on the system you want to install it in. Additional drive cartridges sell for $595; additional docking brackets are $50. For a 20-MB drive, that's expensive. But to be fair, new technology is always initially exorbitant. If you want or need true data portability and security, the Disctec 20 is a logical choice. ■

Stan Miastkowski is a BYTE senior news editor. He can be contacted on BIX as "stanm."

BYTE LAB

Disctec 20

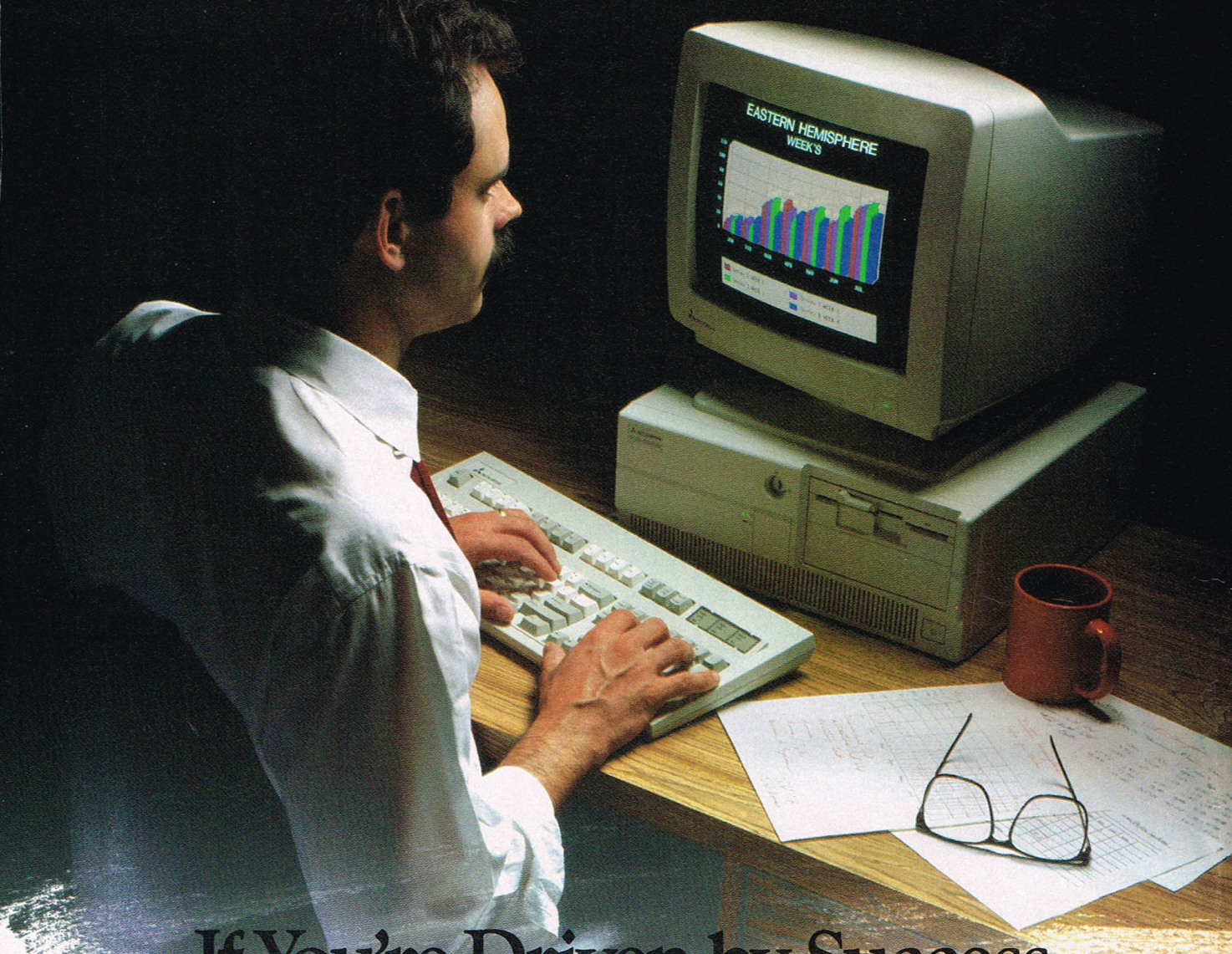
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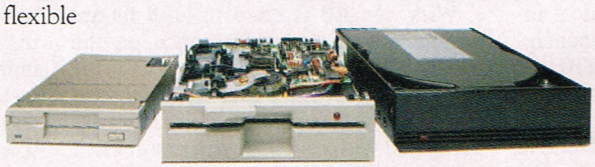
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Circle 231 on Reader Service Card (RESELLERS: 232)

Reviewer's Notebook provides new information—including version updates, new test data, long-term usage reports, and reader feedback—on products previously reviewed in BYTE.

ALR Pumps Up PowerFlex



ALR has added the PowerFlex 20CSX, a Windows-ready 20-MHz 386SX PC, to its popular PowerFlex line.

PowerFlex 20CSX Model 110

Company
Advanced Logic Research, Inc.
9401 Jeronimo
Irvine, CA 92718
(714) 581-6770

Components (as tested)
Processor: 20-MHz 386SX; 20-MHz 80387SX FPU
Memory: 3 MB of 80-ns DRAM, expandable to 5 MB on motherboard and to 16 MB total; 32K-byte static RAM cache
Mass storage: 3½-inch 1.44-MB Teac floppy disk drive; 106-MB 25-ms 3½-inch Toshiba IDE hard disk drive
Display: ALR 800- by 600-pixel Super VGA controller with ALR FlexView 2X Super VGA monitor
Keyboard: 101-key modified IBM Enhanced AT layout
I/O interfaces: One serial, one parallel, and one mouse port; one 8-bit and five 16-bit ISA expansion slots (five open)

Price
$4008

Inquiry 1075.

Reviewed in the June issue, the 286-based ALR PowerFlex and its upgradable architecture provides a cost-effective means of keeping your DOS-based system current with the demands of your applications. Advanced Logic Research recently introduced a new PowerFlex model, the 20CSX, which begins life as a 20-MHz 386SX-based PC and is upgradable to a 25-MHz 486. Like the earlier version, the 20CSX is relatively inexpensive and well made. The two systems also share the same 16-bit bus architecture, which forces you to pay a performance penalty when using the 32-bit i486 CPU.

The 20CSX does not replace the earlier PowerFlex. It is a midrange model that ALR is aiming at users of graphical interfaces such as Windows, and its configuration reflects that. The Model 110 that ALR sent to BYTE comes standard with 3 megabytes of RAM, an 800- by 600-pixel Super VGA card, a 25-millisecond 106-MB hard disk drive with an Intelligent Drive Electronics controller, and a two-button mouse. It also sports a 32K-byte static RAM cache. In all other aspects, the 20CSX is the same machine as the original PowerFlex (see "Two to Grow On," June BYTE).

Good Performer

The BYTE Lab benchmarked the PowerFlex 20CSX in its 386SX mode. Benchmark indexes for the 486 version should be similar to those achieved by the original PowerFlex. As the graph shows, the 20CSX performs comparably to the Compaq Deskpro 386s/20 in both the low-level and application suites; the major difference is the ALR's significantly better CPU index: 2.49 versus the Compaq's 1.76.

Windows 3.0 is crisp in both its appearance and its performance on the 20CSX. The Super VGA video with the ALR FlexView 2X Super VGA monitor eliminates the fuzziness sometimes experienced with lesser graphics systems. I experienced no compatibility problems with the ALR system.

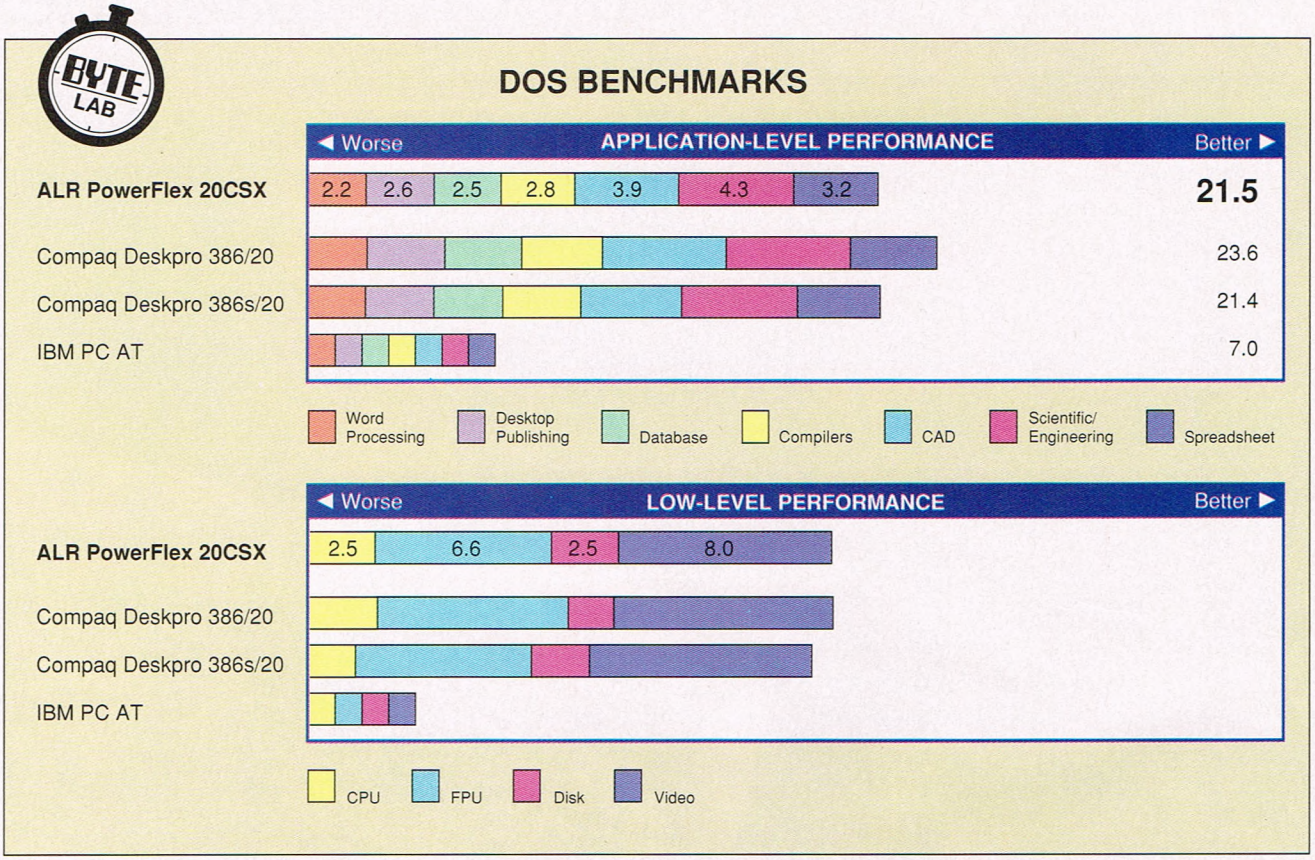
Like the original FlexCache system, the 20CSX is ruggedly constructed. The case fits correctly and is easy to remove and replace, and the motherboard is firmly mounted. Installing add-in cards flexes the electronics very little. I found no last-minute engineering modifications in the system.

One for the Budget-Conscious

Among all the 20-MHz 386SX systems BYTE has reviewed, the 20CSX is a standout. It is one of the best performers, comes Windows-ready, and provides a means of increasing the horsepower as needed. It's also among the lowest priced at $3349 (without the math coprocessor).

Its biggest drawback is still its 16-bit bus, which prevents the system from taking full advantage of the i486. As the demands of your applications increase, you just might need all of that i486. Nonetheless, the PowerFlex 20CSX is an attractive starting platform for the business user or professional moving to Windows.

—Michael Nadeau



For application and low-level benchmarks, results are indexed and show relative performance; for each individual index, an 8-MHz IBM PC AT running MS-DOS 3.30 = 1. For all benchmarks, higher numbers indicate better performance.

The BYTE low-level benchmark suite identifies performance differences between machines at the hardware level; the application benchmarks evaluate real-world performance by running a standard test suite using commercially available applications. Application indexes include tests using the following programs: Word Processing: WordPerfect 5.0; Desktop Publishing: Aldus PageMaker 3.0; Database: Borland Paradox 3.0 and Ashton-Tate dBASE IV; Compilers: Microsoft C 5.1 and Borland Turbo Pascal 5.5; CAD: AutoCAD release 10 and Generic CADD level 3 1.1.5; Scientific/Engineering: Stata release 2, MathCAD 2.5, and PC-Matlab 3.5f; and Spreadsheet: Lotus 1-2-3 release 3.0 and Microsoft Excel 2.1.

For more information on all the BYTE benchmarks, see "BYTE's New Benchmarks: New Looks, New Numbers" on page 158 in the August issue.

Hard Disk Confusion at Micro Express

In BYTE's Product Focus on 386SX systems (see "386SX PCs: Heirs to the Low End," August), we recommended Micro Express's ME 386 SX/SL, based in part on its fast (19 millisecond) Quantum ProDrive hard disk drive. Since then, some readers have reported that they had received slower hard disk drives in the systems that they ordered. Readers also reported having problems contacting Micro Express and receiving technical support.

BYTE repeatedly called Micro Express, posing as a customer, and did experience problems getting through to both sales representatives and technical-support personnel. When we asked what hard disk drive was shipped with the system, two salespeople cited a 28-ms Western Digital hard disk drive; another cited a more comparable 23-ms Conner Peripherals hard disk drive. None of the salespeople mentioned the Quantum ProDrive.

A Micro Express spokesperson said that favorable reviews of the ME 386 SX/SL had caused a rush of orders that overloaded the company's telephone system and created temporary product shortages and support problems. He added that the company is working to correct these problems.

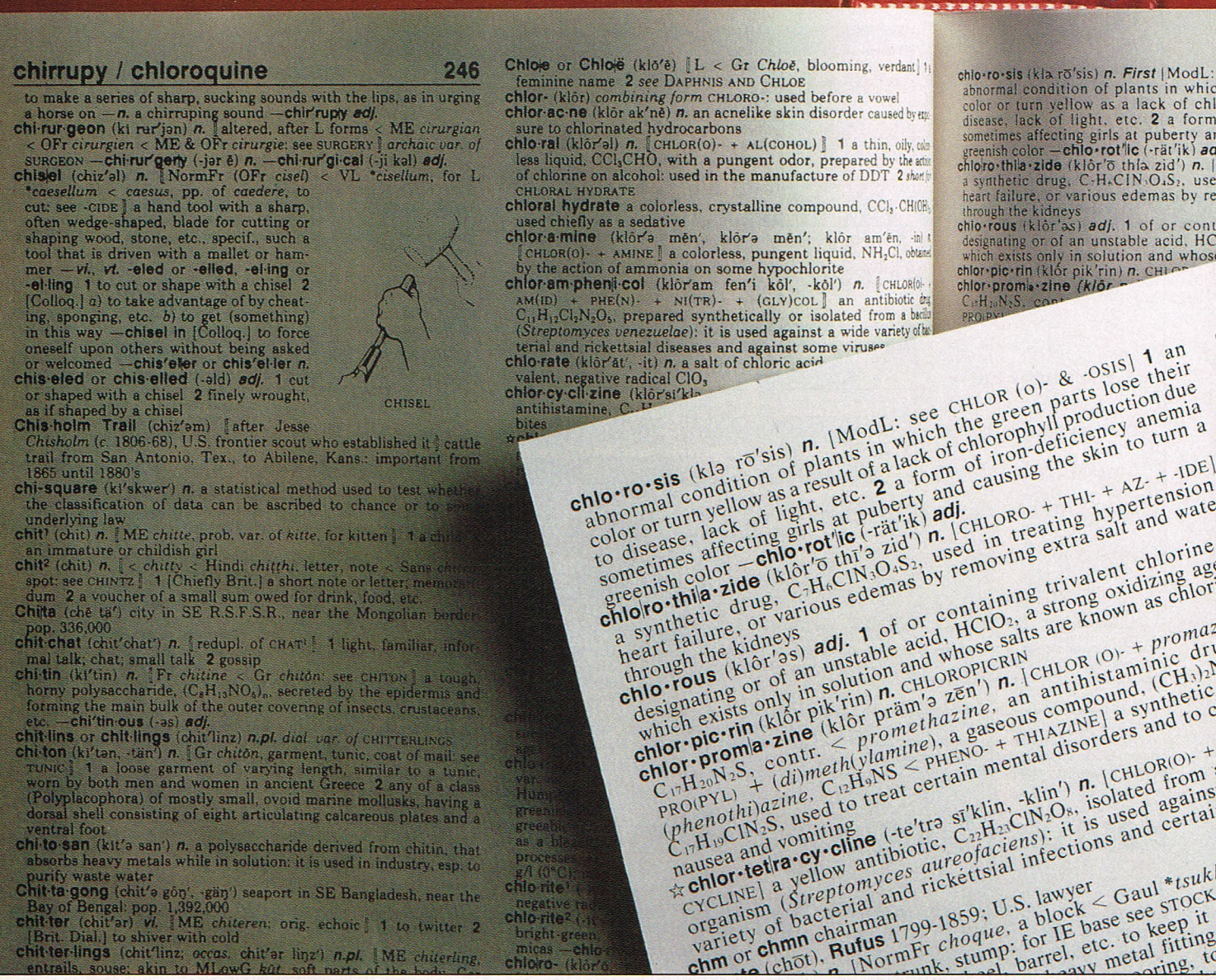
Micro Express confirmed that it no longer sells the 40-MB 19-ms Quantum ProDrive and claimed that it was offering a comparably equipped system with either a 28-ms Western Digital hard disk drive for $1799 or an 80-MB 19-ms Quantum ProDrive for $1899. (The system that we tested for the Product Focus, with 2 MB of RAM, a 40-MB hard disk drive, and a color analog monitor, cost $1945.) In subsequent calls, Micro Express salespersons did offer these alternatives, but they quoted $1999 for the system with the 80-MB Quantum ProDrive and incorrectly stated the average access time for the Western Digital hard disk drive as 23 ms.

Most system vendors "second source" major components to ensure an adequate supply. Usually, these components offer roughly equivalent performance to the components they replace; occasionally, however, they do not. BYTE strongly urges readers to specify the subsystem components that they want when ordering a system. (A description of components in our test systems accompanies every BYTE review.) If a part isn't in stock, most companies will special-order it for you.

As for Micro Express, we are confused about exactly what the company is offering.

—Rob Mitchell

With HP's enhanced OCR capabilities,



chirrupy / chloroquine 246

to make a series of sharp, sucking sounds with the lips, as in urging a horse on —*n.* a chirruping sound —**chir'rupy** *adj.*

chi·rur·geon (ki rur'jən) *n.* [altered, after L forms < ME *cirurgian* < OFr *cirurgien* < ME & OFr *cirurgie*: see SURGERY] *archaic var. of* SURGEON —**chi·rur'ger·y** (-jər ē) *n.* —**chi·rur'gi·cal** (-ji kəl) *adj.*

chisel (chiz'əl) *n.* [NormFr (OFr *cisel*) < VL **cisellum*, for L **caesellum* < *caesus*, pp. of *caedere*, to cut: see -CIDE] a hand tool with a sharp, often wedge-shaped, blade for cutting or shaping wood, stone, etc., specif., such a tool that is driven with a mallet or hammer —*vi., vt.* **-eled** or **-elled**, **-el·ing** or **-el·ling** 1 to cut or shape with a chisel 2 [Colloq.] *a)* to take advantage of by cheating, sponging, etc. *b)* to get (something) in this way —**chisel in** [Colloq.] to force oneself upon others without being asked or welcomed —**chis'el·er** or **chis'el·ler** *n.*

CHISEL

chis·eled or **chis·elled** (-əld) *adj.* 1 cut or shaped with a chisel 2 finely wrought, as if shaped by a chisel

Chis·holm Trail (chiz'əm) [after Jesse *Chisholm* (c. 1806-68), U.S. frontier scout who established it] cattle trail from San Antonio, Tex., to Abilene, Kans.: important from 1865 until 1880's

chi-square (ki'skwer') *n.* a statistical method used to test whether the classification of data can be ascribed to chance or to some underlying law

chit[1] (chit) *n.* [ME *chitte*, prob. var. of *kitte*, for kitten] 1 a child; esp., an immature or childish girl

chit[2] (chit) *n.* [< *chitty* < Hindi *chitthi*, letter, note < Sans *chitra*, spot: see CHINTZ] 1 [Chiefly Brit.] a short note or letter; memorandum 2 a voucher of a small sum owed for drink, food, etc.

Chi·ta (chē tä') city in SE R.S.F.S.R., near the Mongolian border; pop. 336,000

chit·chat (chit'chat') *n.* [redupl. of CHAT[1]] 1 light, familiar, informal talk; chat; small talk 2 gossip

chi·tin (ki'tin) *n.* [Fr *chitine* < Gr *chitōn*: see CHITON] a tough, horny polysaccharide, $(C_8H_{13}NO_5)_n$, secreted by the epidermis and forming the main bulk of the outer covering of insects, crustaceans, etc. —**chi'tin·ous** (-əs) *adj.*

chit·lins or **chit·lings** (chit'linz) *n.pl. dial. var. of* CHITTERLINGS

chi·ton (ki'tən, -tän') *n.* [Gr *chitōn*, garment, tunic, coat of mail: see TUNIC] 1 a loose garment of varying length, similar to a tunic, worn by both men and women in ancient Greece 2 any of a class (Polyplacophora) of mostly small, ovoid marine mollusks, having a dorsal shell consisting of eight articulating calcareous plates and a ventral foot

chi·to·san (kit'ə san') *n.* a polysaccharide derived from chitin, that absorbs heavy metals while in solution: it is used in industry, esp. to purify waste water

Chit·ta·gong (chit'ə gôŋ', -gäŋ') seaport in SE Bangladesh, near the Bay of Bengal: pop. 1,392,000

chit·ter (chit'ər) *vi.* [ME *chiteren*; orig. echoic] 1 to twitter 2 [Brit. Dial.] to shiver with cold

chit·ter·lings (chit'linz; *occas.* chit'ər linz') *n.pl.* [ME *chiterling*, entrails, souse; akin to MLowG *kūt*, soft parts of the body; C

Chloe or **Chloë** (klō'ē) [L < Gr *Chloē*, blooming, verdant] 1 feminine name 2 *see* DAPHNIS AND CHLOE

chlor- (klôr) *combining form* CHLORO-: used before a vowel

chlor·ac·ne (klôr ak'nē) *n.* an acnelike skin disorder caused by exposure to chlorinated hydrocarbons

chlo·ral (klôr'əl) *n.* [CHLOR(O)- + AL(COHOL)] 1 a thin, oily, colorless liquid, CCl_3CHO, with a pungent odor, prepared by the action of chlorine on alcohol: used in the manufacture of DDT 2 *short for* CHLORAL HYDRATE

chloral hydrate a colorless, crystalline compound, $CCl_3 \cdot CH(OH)_2$, used chiefly as a sedative

chlor·a·mine (klôr'ə mēn', klôr'ə mēn'; klôr am'ēn, -in) [CHLOR(O)- + AMINE] a colorless, pungent liquid, NH_2Cl, obtained by the action of ammonia on some hypochlorite

chlor·am·phen·i·col (klôr'am fen'i kôl', -kōl') *n.* [CHLOR(O)- + AM(ID) + PHE(N)- + NI(TR)- + (GLY)COL] an antibiotic drug, $C_{11}H_{12}Cl_2N_2O_5$, prepared synthetically or isolated from a bacillus (*Streptomyces venezuelae*): it is used against a wide variety of bacterial and rickettsial diseases and against some viruses

chlo·rate (klôr'āt', -it) *n.* a salt of chloric acid

chlor·cy·cli·zine (klôr'si'kli- antihistamine, C. bites

chlo·ro·sis (klə rō'sis) *n.* [ModL: see CHLOR(O)- & -OSIS] 1 an abnormal condition of plants in which the green parts lose their color or turn yellow as a result of a lack of chlorophyll production due to disease, lack of light, etc. 2 a form of iron-deficiency anemia sometimes affecting girls at puberty and causing the skin to turn a greenish color —**chlo·rot'ic** (-rät'ik) *adj.*

chlo·ro·thi·a·zide (klôr'ō thī'ə zid') *n.* [CHLORO- + THI- + AZ- + -IDE] a synthetic drug, $C_7H_6ClN_3O_4S_2$, used in treating hypertension, heart failure, or various edemas by removing extra salt and water through the kidneys

chlo·rous (klôr'əs) *adj.* 1 of or containing trivalent chlorine 2 designating or of an unstable acid, $HClO_2$, a strong oxidizing agent which exists only in solution and whose salts are known as chlorites

chlor·pic·rin (klôr pik'rin) *n.* CHLOROPICRIN

chlor·prom·a·zine (klôr präm'ə zēn') *n.* [CHLOR(O)- + *promazine* (*phenothi*)*azine*, contr. < *promethazine*, an antihistaminic drug, $C_{17}H_{20}N_2S$, + (*di*)*meth*(*ylamine*), $C_{12}H_9NS$ < PHENO- + THIAZINE] a synthetic drug, $C_{17}H_{19}ClN_2S$, used to treat certain mental disorders and to control nausea and vomiting

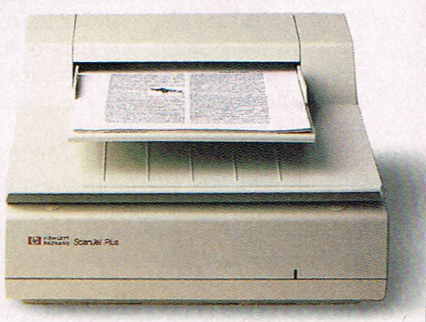
☆**chlor·tet·ra·cy·cline** (-te'trə sī'klin, -klin') *n.* [CHLOR(O)- + CYCLINE] a yellow antibiotic, $C_{22}H_{23}ClN_2O_8$, isolated from an organism (*Streptomyces aureofaciens*): it is used against a wide variety of bacterial and rickettsial infections and certain

chm or **chmn** chairman

Rufus 1799-1859; U.S. lawyer

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text scanning software, AccuScan, simplifies the scanning process by recognizing the layout of even the most complicated material. Including multi-column pages and numerical tables. AccuScan automatically separates text from graphics, making it easy for you to pick and choose the information you want. An optional twenty-page automatic document feeder makes you even more efficient.

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HEWLETT PACKARD

*Suggested U.S. list price without document feeder. © 1990 Hewlett-Packard Company PE12036

Magnetic vs. Optical

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Mass storage is the subject of one of the hottest debates in the computer industry. Will optical media replace magnetic media? Many people think it's only a matter of time. But magnetic media are far from dead. In fact, they outperform optical media by a significant margin.

Perhaps magnetic will withstand the challenge it faces from optical. Perhaps it won't. Or perhaps the two will merge into a hybrid form. In "State of the Media," David A. Harvey looks at the advantages and disadvantages of each and explores the possibilities of hybrid technologies combining the good points of both. And in a related text box, "Playing Catch-Up," Andrew Reinhardt explores the confusion that is the standards' environment for optical storage.

One of the wildest ideas I've heard in a long time is that of storing data in crystals with light. This is no hocus-pocus. In "Crystal Clear Storage," Tom Parish examines holographic data storage, a technology whose capacity dwarfs even that of optical disks, while giving you faster access to your data.

Another new optical storage technology, called *phase change*, uses a whole new method for storing data on an optical disk. In the process, it merges the capacity of magneto-optical storage with a performance better than that of traditional optical storage. It may bridge the gap between magnetic and optical. In "Entering a New Phase," Bob Ryan describes how phase-change technology works and its potential for the future.

The most popular form of magnetic technology is the disk, be it a hard disk or a floppy. If magnetic disk technologies are to remain healthy, they will have to continue to evolve, in speed, in capacity, in densities, and in recording means and materials. In "The Once and Future King," Bob Ryan looks at new disk technologies, what they are and how they are likely to affect future disk drives. In the text box "Side by Side," Bill Passavanti discusses perpendicular recording, a new way to put more bits onto a disk.

Another new form of "disk" technology is solid-state. Flash-memory ICs, contained on credit-card-size devices, are entering the microcomputer arena. Because of their size, they will probably invade the laptop market first, and take it by storm. In "Store Data in a Flash," Walter Lahti and Dean McCarron explain what flash memory is, what it is likely to be used for, and why.

After disks, the next most popular magnetic medium is tape. You don't tend to think of magnetic tape when you think of microcomputers, but as systems become larger and more complex, backups become more important. When disk-to-disk backups are no longer practical, tape provides an alternative. In "DAT's a Solution," Karina Lion examines the advantages of digital audiotape and explores quarter-inch cartridge and 8-mm options as well.

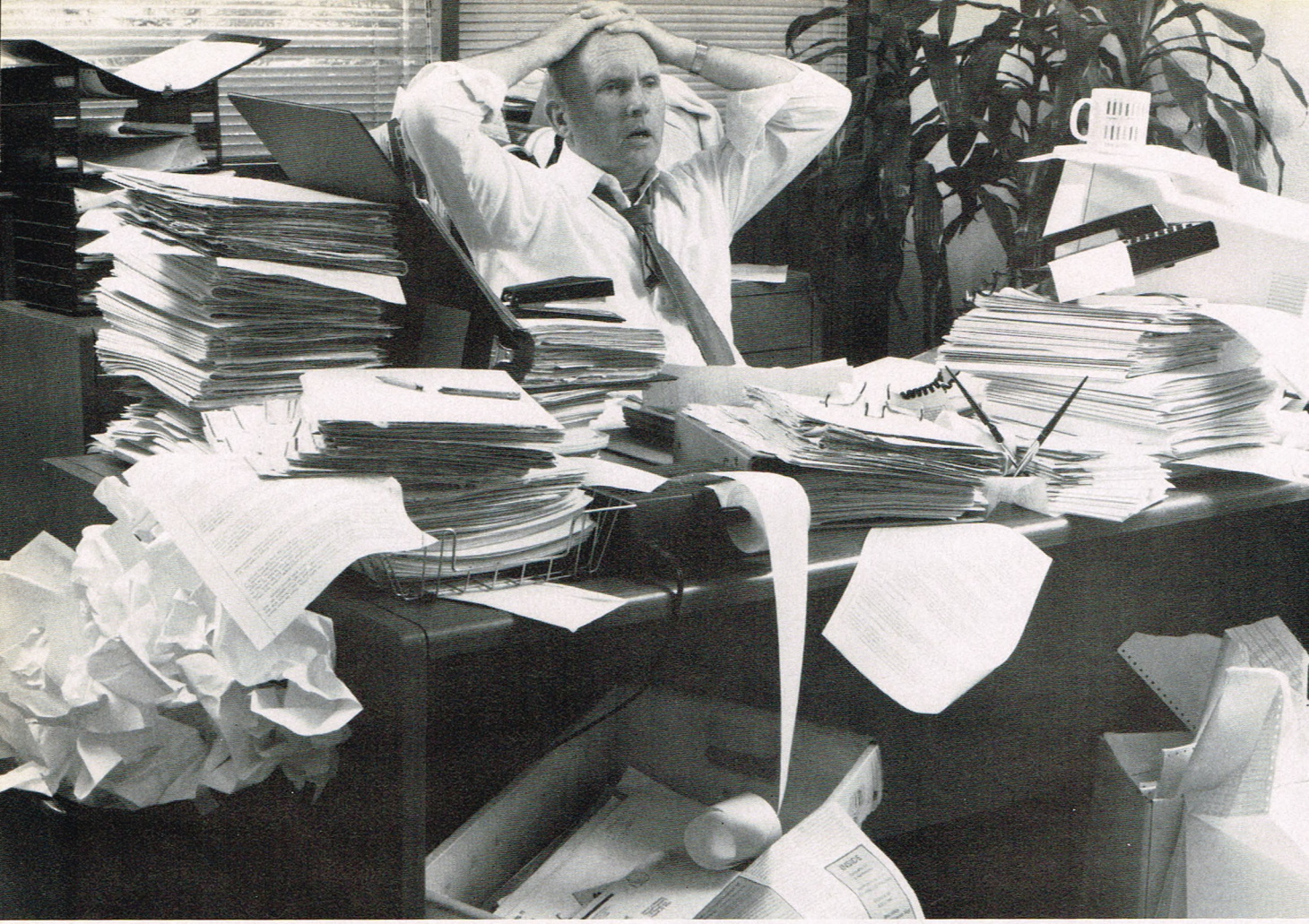
Whether you use magnetic or optical media, data compression is becoming the rule rather than the exception in an effort to cram more data into existing space. In "Getting Your Byte's Worth," Steven J. Vaughan-Nichols examines hardware-based data compression. It is so transparent and automatic, you'll never know you're using it.

As data continues to proliferate, the optical versus magnetic debate will continue, and new and improved technologies will appear on both sides—and in the middle. So let the opposing factions fight it out. We'll just watch—and collect the spoils.

—Jane Morrill Tazelaar
Senior Editor, State of the Art



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State of the Media

Magnetic vs. optical: Is it the war of the disk drives or a marriage of convenience?

David A. Harvey



How far the microcomputer industry has come in a decade or so. It wasn't so long ago that all data was stored on cassette tapes. At that time, the advent of the single-sided floppy disk seemed like a miracle.

Today, with a 150-megabyte hard disk drive, two CD-ROM units, and a 1-gigabyte magneto-optical drive—not to mention double-sided high-density floppy disk drives—serving for storage, thoughts of single-sided disks give me acute claustrophobia. However, the more places you have to put data, the more confusing it can become to decide which device to use.

As much as we'd all like to have the newest and most innovative technologies on our desks, the primary question is, "Which storage option is really appropriate to your needs?" If you listen to all the hype, you're going to hear conflicting reports.

The makers of traditional magnetic drives will tell you that they provide a faster and more tested technology, and that the capacity of hard disk drives is increasing daily. The producers of optical drives are prone to elaborate on how the time has come for optical drives to replace all other mass storage devices. And floppy disk drives continue to grow bigger and faster, too.

Ultimately, the industry will probably evolve toward one standard way of storing information. From here, that future looks optical. But for now, the choices you make will affect not only your productivity, but also how you work.

The conflict between traditional magnetic mass storage devices and optical technologies includes questions of speed, cost, data migration, archival needs, and the amount of data you need to store. The most important difference between the two technologies lies in how they let you manipulate the data.

Magnetic Racing Stripes

If the data associated with your primary applications is contained in executable and temporary files, in discrete and manageable data files, then you probably want a hard disk drive. The advantages of hard disk drives include their speed, cost, and universality.

No optical device on the market can even come close to matching the speed of a generic Intelligent Drive Electronics drive with a software cache thrown in. And optical drives can't begin to touch an ESDI hard disk drive with 0.5-millisecond access time, throughput greater than 1 megabyte, and a bus-mastered caching controller on an Extended Industry Standard Architecture bus.

If you need your data nearly instantaneously, if a hard disk can contain it, and if you have a good backup system worked out for that data, then you probably have

ILLUSTRATION: JOE GAST © 1990

no reason to go optical. Optical devices are not so slow that they're unusable, however. Some of the newer rewritable devices, both phase-change and magneto-optical, are fast approaching hard disk drive speeds.

Optical drives are slow for a number of reasons. CD-ROMs and some WORM (write once, read many times) drives use constant linear velocity (CLV)—data is organized sequentially in one continuous spiral track, rather than in tracks and sectors (see figure 1). When you want information, the read head must find the temporal position of the data rather than moving to a logical address. The process of finding a specific piece of information is analogous to scanning a compact disk to find a particular passage of music: The read head must move along the entire track until it gets to the data.

Read-write optical drives employ constant angular velocity (CAV)—data is organized into sectors and tracks (see figure 2). The read-write head is heavier than a conventional hard disk drive's, and thus it takes longer to physically move the head to a given location.

Until now, the real degradation in rewritable optical drive performance was tied to the technology of the magneto-optical drive. On an MO drive, writing a byte of information requires two passes. An erase pass restores the disk to its original state; then a write pass adjusts the magnetization to reflect the bit pattern of the data. With the advent of phase-change technology, which can do one-pass writes (see "Entering a New Phase" on page 289), the performance of rewritable optical devices will improve tremendously.

A traditional hard disk drive is still the best bet for primary mass storage.

Even without phase-change technology, however, MO drives are relatively fast. The Storage Dimensions LaserStor on my desk reports an average seek time of about 40 ms. To put that into perspective, it's about as fast as a Seagate ST251 and faster than an ST225.

What all this means is that if you are using disk-intensive programs—animation packages, spreadsheet and database programs, programs that make frequent use of temporary files, or anything that uses the hard disk drive for virtual memory—you're far better off using a traditional hard disk drive to store your information.

The Magnetic Advantage

Physical size and power requirements are another advantage of hard disk units. Within the last few years, hard disk drives have become smaller and required less power. It's reached the point where if you look in almost any laptop, you'll find a 2½-inch form-factor drive. The disk in this drive holds between 20 MB and 100 MB of data and can run for hours on battery power.

Optical drives, on the other hand, are bulkier and require more power. With the exception of CD-ROM drives, which come in a 5¼-inch half-height form factor, most optical drives are full-height 5¼-inch models—too large for laptops. (A slew of full-height 3½-inch optical drives are expected to hit the market this year.) More and more manufacturers are making half-height optical drives, but even these are too big and too heavy for a laptop. You'll see them sooner in AC-only transportables and luggables.

As long as you don't continually run out of available storage space, hard disk drives are your most economic solution. This means not only that it's going to cost you less to store your data, but also that you can upgrade or add new drives as you need them. With SCSI drives or a multidrive controller, like PSI's hyperStore, you can easily circumvent DOS's two-drive limitation and add as many drives as you need.

The start-up cost for WORM or rewritable drives is still high. At best, you're going to pay in the neighborhood of $3500 for an optical drive, a controller, and one piece of media. However, additional disks cost only $100 to $200. In the long run, if you're dealing with massive quantities of information, an optical system may be cheaper.

A traditional magnetic hard disk drive is still the best bet for a primary mass storage system. In this role, an optical drive just can't compete with a hard disk drive's price, performance, and overall

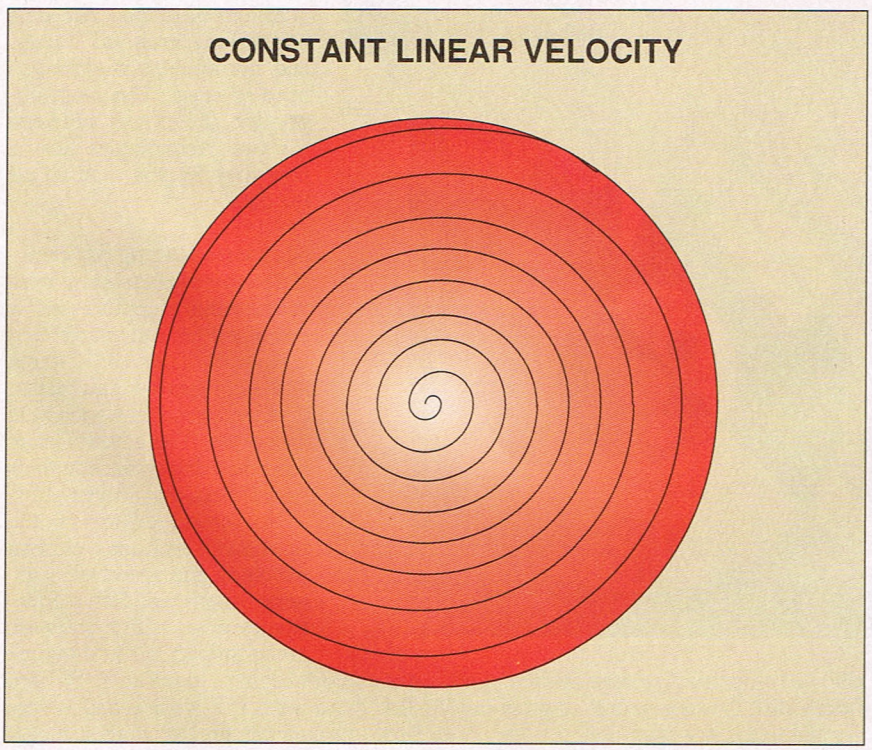


Figure 1: *In constant linear velocity (CLV) recording, data is arranged in a single spiral track with a uniform density of bits. This lets you pack the most information possible onto the disk. The speed of the disk varies between the outer and inner edges—the closer the read head gets to the outer edge, the faster the disk spins. Data is located by its temporal position, measured in minutes and seconds. Each second consists of 2K bytes of data.*

functionality. For example, the NeXT Computer came initially with only a rewritable optical drive. However, because this device proved too slow for its virtual memory file swapping, NeXT added a conventional hard disk drive to speed up the operation.

That doesn't mean that there aren't any uses for optical devices. Quite the opposite, in fact. Document storage and retrieval, graphical image databases, medical diagnostic references, and the storage of multiple versions of files are some of the applications best suited to optical storage. And when put to good use, an optical storage system can be an essential part of a computer system.

The Optical Advantage

The limitations of hard disk drives become apparent when you deal with large volumes of data that in turn require a lot of space for backup. If you're dealing with 1 gigabyte of data, you could opt for mirrored 1-gigabyte hard disk drives. But when the data enters the multigigabyte or even terabyte range, hard disk drive solutions become unmanageable.

Optical drives can store more information in less space than hard disk drives can. Since optical drives use easily removed and inserted cartridges, you can use a single drive to manage unlimited amounts of information. And with jukebox-style changers, in which a robotic arm handles disk changing and selection, you can have terabytes on-line.

The optical storage advantage occurs because the laser is more precise and requires less room to write the same amount of data than the write head of a magnetic hard disk drive does. With WORM drives, which usually encode bytes of information as pits on the surface of the disk, this means both more information in a smaller space, and a more secure store of data—the pits are a relatively permanent form of encryption and are not affected by magnetic fields.

More storage space doesn't just mean cramming more onto a disk, however. It fundamentally changes what you can do with your personal computer. Instead of dealing with only part of a set of data, you can have all the data in one place at one time. If you work with large images, an optical drive not only allows you to store the images in one place, but it makes them easier to manipulate, compare, and analyze.

Optical devices are particularly suited to storing documents. Using software designed for file management, such as N/Hance's TextScan or Lotus's Magellan, you can sort and group documents contextually. The advantage to this isn't just speed. It allows you to group documents in ways that were impossible when they weren't all accessible for complex word searches.

Another benefit to optical drives is that you can store both a graphical image of the original document and a text copy on the disk. This is useful for performing signature verification or for including diagrams and photographs. The possibilities are endless with this kind of storage.

One real-world example comes from Bill Ford, president of On-Line Computer Systems. Using CD-ROM and the company's retrieval technology, On-Line devised a troubleshooting disk for a telecommunications switch. Technical specifications, the switch's software code, documentation, and diagrams of the switch were linked together by the retrieval engine. Using this tool, it is possible to click on, say, a variable, get its definition, and retrieve every module and procedure that references that particular piece of code.

People have an associative memory and a relatively brief duration of retention in short-term memory. The availability of more information organized relative to context rather than to content means that you can draw different conclusions than if you could only access the data in bits and pieces.

Wanted: Standards for Optical

Optical drives are akin to giant floppy disk drives. Therefore, data exchange between users is as easy as "sneaker" net. Proprietary installable file systems also make data migration between different operating systems possible.

By implementing an installable file system that runs as a TSR program (using interrupt 21 hexadecimal under DOS) or as an IFS driver (for OS/2 and Unix), the only thing you need is to install the appropriate software on each operating system. This approach has also been applied to rewritable drives.

Another benefit of the IFSes used for WORMs or virtual WORMs (rewritable drives using a write-once file system) is archive tracking. When you save a new copy of a file to a WORM device, it doesn't overwrite the old one. Usually when you save a new version of a file, only the changed sectors are written to

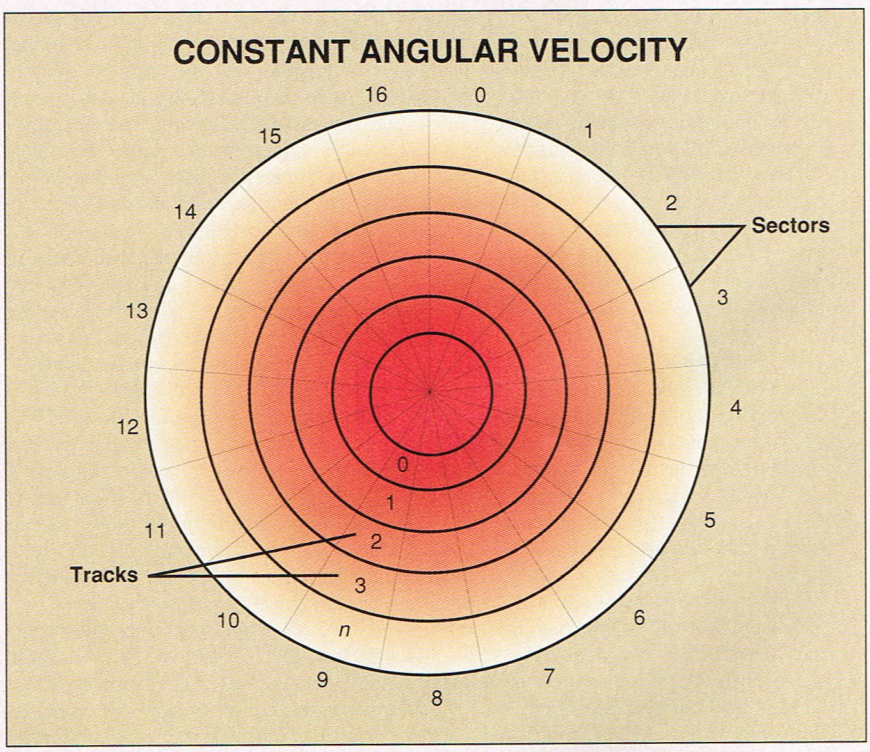


Figure 2: *Constant angular velocity (CAV) is the organization of data into sectors and tracks. Because the number of bits per sector remains constant with CAV, data is packed most tightly in the shorter tracks near the center of the disk. Although this method cannot pack as much data onto a disk as CLV can, the sector/track addressing method makes locating data much faster with CAV than with CLV.*

Playing Catch-Up

Andrew Reinhardt

Hoping to avoid the chaos of incompatibility that has plagued the WORM (write once, read many times) drive market, manufacturers and standards committees tried to get a jump on standards for 5¼-inch rewritable magneto-optical (MO) drives. For a while, it seemed they had succeeded: Except for the Canon drive used in the NeXT Computer, all the MO drives introduced since the fall of 1988 have adhered to the draft ANSI and International Standards Organization (ISO) standards.

But now the situation has grown more complicated. At Spring Comdex last June, Pioneer Communications and Laser Magnetic Storage (LMS) introduced "multifunction" drives that support both WORM and MO media but use a different format than other rewritables. And in August, Hewlett-Packard, Sony, and 12 other companies announced a specification that would allow standard rewritable optical drives to be used in a write-once mode.

The emergence of alternate technologies, on the eve of the ISO's expected approval of a worldwide standard, has thrown the market into confusion and sparked calls to reopen standards discussions. All this wrangling concerns only 5¼-inch media using MO technology; standards for 3½-inch disks and phase-change media are years off.

The Near Standard

The ANSI's X3B11 committee is now considering only one standard for 5¼-inch rewritable optical disks, using MO media and a formatting scheme called *continuous composite servo*, or CCS. In CCS, the disk is etched at the factory with a spiral of grooves that define the location of data tracks. Two tracking heads read the grooves constantly to position and focus the third head precisely over the data.

In contrast, by the time you read this, the ISO will likely have approved two versions of the standard for MO drives that are identical in all respects except for the servo technique. The standard, called ISO DIS 10089, specifies a Format A, which is CCS, and a Format B, which is *sampled servo*, or SS. The latter does not use grooved tracks or multiple heads; instead, bits that align the single head are mixed in with the data.

An SS disk is stamped at the factory with regions of precisely calibrated pits that tell the head where a data track is located. In the ISO specification, there are 32 sectors per track and 43 servo segments per sector, so in a single rotation of the disk, the head's position is calibrated almost 1400 times; even so, it has to be much more precise than in a CCS mechanism. Besides telling the track location, servo regions are also used to focus the head and provide clock synchronization.

The Battle of the Servos

CCS traces its roots back to analog-video laser disks. As an older and more mature technology, it is considered a safer bet than SS. CCS-formatted media are easier, though more time-consuming, to manufacture, whereas SS media require more expensive and advanced equipment, but they are faster to make because disks can be stamped. In the end, the manufacturing contest between the two is a draw, because current technology makes both equally feasible; any differences in price are due to production volumes, which favor CCS.

The more germane advantages of SS, according to its proponents, are that it offers superior speed and accuracy, as well as the potential for greater disk capacity. SS drives handle data and servo information separately and sequentially, whereas CCS drives must deal with both simultaneously. Therefore, CCS drives need greater processing capacity to achieve equivalent data throughput. More important, CCS drives can experience cross talk between the data and tracking grooves: Because this interference is absent from SS drives, SS offers a better signal-to-noise ratio.

Since SS drives have only one head, which saves a lot of mass, they can seek tracks faster. And because surface area on the disk is not used up for tracking grooves, SS disks can have many more tracks, although current standards do not specify that. (Because some of each track is used up for servo information, SS disks hold less data per track. In the ISO format, enough additional tracks are added that the net capacity of both formats is the same.)

Pioneer and LMS developed SS MO drives because they already sell SS WORM drives and wanted to provide an upgrade path for current users. The advantage is that you only need a single drive unit to use both WORM and rewritable media. By contrast, the CCS MO drives, marketed by Sony, Ricoh, and others, can't read from or write to any other optical media. Pioneer and its cohorts asked ANSI to consider adding a specification for SS to its 5¼-inch MO standard, but the membership voted strongly against the request in a May meeting. So, only the ISO will document SS.

Magneto-Optical Multifunction

The consortium headed by Hewlett-Packard has responded to the Pioneer-type multifunction drives with a proposal to give MO drives an "archival" capability. Such drives would also be multifunctional, but they would use only MO media. However, you would still need to stock separate disks for permanent and temporary storage because each would be coded differently at the factory.

The Hewlett-Packard specification would supplement the current ANSI/ISO specifications, but neither standards organization has plans at this time to incorporate it into published documents. However, with Hewlett-Packard, Sony, Maxoptix, Olympus/Ricoh, Seiko/Epson, Philips–Du Pont Optical, 3M, Fuji, Mitsui, and Asahi backing it, the specification may become a de facto standard even if it is never formally adopted.

In a nutshell, the Hewlett-Packard scheme takes advantage of fields that are defined but unused in the current ISO standard. These fields would be used to set flags indicating that the rewritable medium was to be used only for permanent storage. While bits would not be permanently burned into the medium as with WORMs, Hewlett-Packard contends that with proper firmware the disks would be as secure as WORM storage—and perhaps longer-lived.

Opponents of the proposal say that if you need write-once storage, you won't want to use disks that could theoretical-

ly be erased. Hewlett-Packard responds that somebody bent on destroying data could also alter a WORM; in any case, its write-once MO proposal offers three levels of security. The most prevalent misconception about the method is that an MO disk written with "permanent" data could be accidentally erased if it were inserted into an older-generation MO drive; in fact, says Hewlett-Packard's Bill Boles, the drive would reject the disk or issue an error message.

The three levels of security are as follows: First, the disk contains two tracks whose contents are coded at the factory to indicate whether it is a rewritable or write-once MO. If the codes indicate that the disk is rewritable, the drive can store data; if not, or if the drive can't read the tracks (as would be the case for older generation media), then no writing is allowed. The second and third levels of protection involve setting flags on the disk—one is an indication written during formatting that the medium is write-only, and the other is a code embedded in each sector that indicates it is locked.

What this means, of course, is that disks can be either write-once or rewritable, but not both. What is the benefit of this scheme over Pioneer's if you still have to use different media, especially when WORM disks are cheaper? Hewlett-Packard answers that MO disks will eventually become less expensive than WORMs because of higher volume. More important, some research now indicates that MO disks are more stable in the long run than WORMs, which are subject to decay from humidity trapped in the data pits.

A Fly in the Ointment

Yet another variant exists for MOs that could further complicate the standards picture. This subset of the CCS format, called *zoned constant angular velocity*, or Z-CAV, is concerned not with pits versus grooves, but only with the arrangement of sectors in tracks. Although neither the ANSI nor the ISO is considering its adoption as a standard right now, a group of vendors, including Maxoptix, Hewlett-Packard, and several media makers, is promoting the speed and capacity benefits of Z-CAV.

All the drives discussed earlier are constant angular velocity (CAV) devices, which means that their motors spin at a constant speed (see figure 2). (By contrast, audio compact disks and CD-ROMs use constant linear velocity, which means that the motor spins at different speeds depending on which track is being read, so that the data passes under the laser at a constant rate. See figure 1.)

CAV disks look like bicycle wheels, with the sectors arranged regularly between the spokes. Z-CAV, on the other hand, takes advantage of the fact that the outer tracks of a disk are longer than the inner tracks. The result is a staggered arrangement of sectors, with an increasing number per track the closer they are to the outer edge. The Tahiti drives from Maxtor can support standard CAV and nonstandard Z-CAV media, and the Z-CAV disks hold 1 gigabyte of data instead of the normal 650 megabytes. Access to data in the outer tracks is also faster than in the CAV arrangement.

Further in the Future

Two other developments loom on the horizon for optical storage. The first is phase change (see "Entering a New Phase" on page 289). The second is 3½-inch drives and media, for which standards are still evolving.

The ANSI and ISO have promulgated draft standards for 3½-inch MO media and drives, and on that basis, a few companies, including Pinnacle Micro and O.C.E.A.N. Microsystems, have already shipped products based on a Nakamichi mechanism. But you may be taking a risk buying these drives, says Ken Hallam, chairperson of the ANSI subcommittee on 5¼-inch MO standards. Buyers of early Sony and Ricoh 5¼-inch MO drives will be able to meet the final ISO standard with a field PROM upgrade, but changes may yet occur to the 3½-inch specification that would render existing products physically incompatible with the final standard.

Hallam says that an agreement on 3½-inch MO standards is at least a year away at the ISO and even further at ANSI because there are still a lot of arguments between committee members. The new specification won't be just a scaled-down version of 5¼-inch standards, because manufacturers want to leapfrog today's drive technology. One possible goal—pushed for mainly by IBM—is to allow both rewritable and read-only (stamped) disks to be used in the same drives. IBM apparently believes 3½-inch media will become an important means of distributing software.

Among the most controversial questions still to be decided is whether the whole disk or only parts of it may be read-only. ANSI is leaning toward allowing only a single track to be read-only because this would simplify tracking and eliminate the need to catalog which parts of the disk are rewritable and which are not. But Japanese vendors and other forces in the ISO want read/write status to be fully interchangeable on a sector-by-sector basis, which would complicate tracking and defect management but increase flexibility.

In any case, if 3½-inch drives have to accommodate read-only media, the specifications for tracking and reflectivity will have to be quite different than in the 5¼-inch specification, because, to a laser beam, stamped bits look different from MO spots. If that is not enough to worry buyers of 3½-inch drives, as recently as August ANSI approved minor changes to the disk cartridge specification that could render current 3½-inch media incompatible with future drives.

A Vicious Cycle

The push and pull between market forces, standards bodies, and what is technically feasible has always been complex, even in the well-planned optical storage area. The problem facing optical drives today is not technology but confusion over standards.

This is a vicious cycle: Uncertainty depresses demand, which keeps volumes low and prices high, which depresses demand, and so on. Until the uncertainty is alleviated, optical drives won't reach their potential.

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disk, and new pointers are ad[d].

Combined with a file syster[n] that manages the pointers, this meth[od] enables you to recover any version of [a]ny file at any time. Such a recovery is p[os]sible because the directory structure o[f a] WORM drive is not stored in a file [a]llocation table; it is saved as discre[te] address pointers located after each sector.

Thus, if you need to keep audit trails of documents, you no longer have to keep multiple floppy disks, directories, or paper copies. This capability makes WORM technology ideal both for backups and, in cases where you always need to have multiple versions available, for primary document storage.

This sounds great, and it would be if you could just install the software, regardless of the drive's manufacturer. Alas, you can't. In the first place, a lot of manufacturers add specialized functions to their bus adapters, and their IFSes are written to take advantage of unique features and capabilities.

While having devices from different manufacturers is normal in many companies, problems arise when you need a different host adapter for each one. Although I've been pleasantly surprised by the relatively few problems I've had with several different bus adapters coexisting in my computer, I've run out of expansion slots.

Universal support of SCSI would mean that any combination of devices could be daisy chained from one host controller. This would not only solve the slot and I/O address problems generated by multiple adapters, but, in the case of bus-mastered SCSI controllers, would result in significant performance advantages.

One thing that appears to be happening, however, is that a number of vendors are moving to support the SCSI-1 and -2 standards for their drives. Sony drives, for example, can be run off a standard Adaptec SCSI controller.

WORM drives especially are beset by standardization problems. Almost every WORM drive on the market uses a different proprietary file system (the same IFSes that make portability between operating systems possible). This means that you can't read disks across different manufacturers' drives. But the problem doesn't end with the file system: WORM drives are so proprietary that for some a pit is a 0 and for others it's a 1.

For MO drives, the situation is slightly better. The International Standards Organization standard was not final when the 5¼-inch MO drive came out, which resulted in some incompatibility between different manufacturers' drives. But the move is toward firmware upgrades and the production of new devices that adhere to the standards. For a detailed look at the standards' situation with all kinds of optical disks, see the text box "Playing Catch-Up" on page 278.

Hopefully, optical drives will move increasingly toward standards for dealing with data storage and for bus interfaces. Much of the promise of the technology would be defeated by a scenario in which drives and disks are manufacturer-specific. Rather than going the route of hard disk drives, which, in general, require you to use the adapter card with which they were formatted, optical drive makers need to pull together and work toward common ground.

If you can truly treat optical drives as giant floppy disk drives, the advantages will be limitless. However, if they become entrenched in proprietary inter-



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faces and ways of dealing with media, I fear that many of their advantages will be lost. The situation is reminiscent of the one users faced trying to use 360K-byte floppy disks in the early 1.2-MB drives.

Optical drives are also more suited for use in environments that are not kind to conventional hard disk drives. The recording techniques of optical drives and the durability of the media mean that heat, vibration, and magnetization are less likely to adversely affect them.

Even though the recording heads on WORM and rewritable drives are still very sensitive, using them to read data in adverse circumstances is more successful than using conventional storage devices. Hard disk drives just weren't built for use under extremely stressful conditions. With a magnetically and physically sensitive disk rotating just microns away from a head, hard disk drives are prone to both magnetic and mechanical disruption.

The nature of optical media promises a longer life than that of conventional magnetic media. In the case of WORMs and CD-ROMs, you have the added security of data permanence. Conservative estimates are that a WORM or a CD-ROM disk will last 60 to 100 years and that the data on an MO disk will remain stable for about 10 years.

A Marriage of Convenience

Traditional magnetic devices and optical storage devices are not mutually exclusive. Rather, they use complementary technologies. The problems arise when you begin to treat them as one and the same. Admittedly, if you don't really need the speed of a fast hard disk drive, you could certainly do very well with a rewritable optical device as your primary storage unit. For most of us, though, faster hard disk drives are essential to getting optimum performance from our applications and our personal computers.

Although data redundancy is a good thing, you don't want to overdo it. When you reach the point where, without any real method or reason, you sometimes use a hard disk drive and sometimes an optical drive as your primary storage device, your productivity will drop in proportion to the number of files that are saved on different devices. It is hard enough to find information on a large hard disk without having to scan over another gigabyte or so of WORM and rewritable disk space.

If you take a sober look at optical technologies, you'll probably find one that will work for you. Personally, I don't know anyone who wouldn't benefit from CD-ROM. At the same time, don't toss your hard disk drive in the trash. Optical drives bring us the ability to do things that conventional magnetic drives cannot; they don't replace them. Chances are, you'll be using your hard disk to hold programs and store your primary data for some time to come.

"A place for everything, and everything in its place" is a good rule of thumb for managing data. When considering the wonders of optical drives, remember that the power of any new technology lies not in what it can do that's already been done, but in what it can do that has previously been impossible. ■

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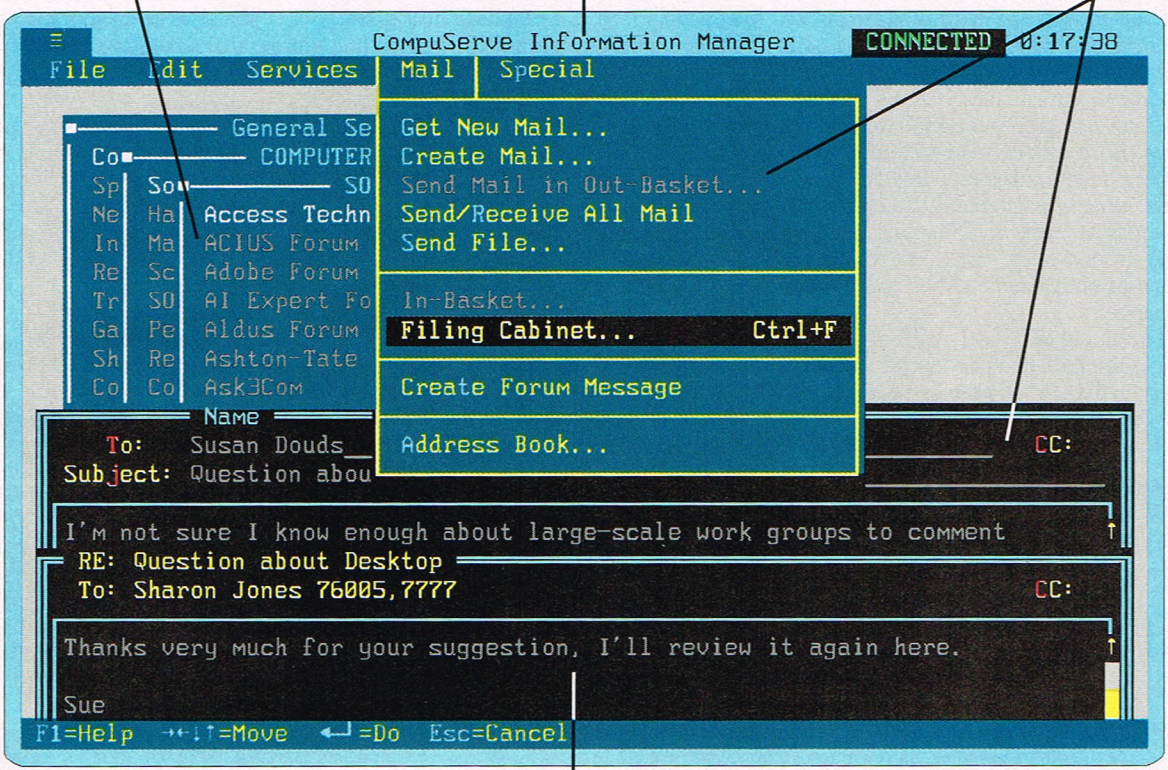
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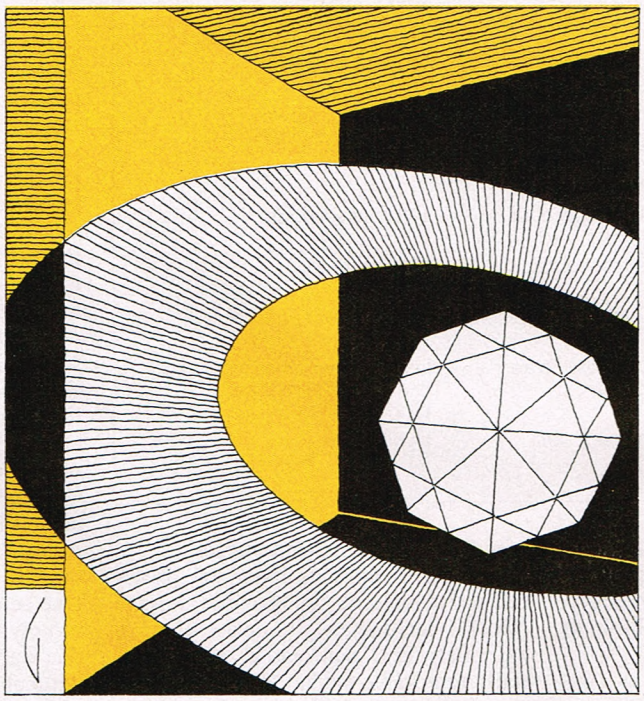
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Tom Parish



It's no surprise to even the layperson these days to hear about tremendous advances in processor speeds for computers. In the 15 years since the first personal computer was introduced, processors have evolved from 4 bits with CPU speeds in the thousands of instructions per second to 32 bits with speeds of up to 50 million instructions per second.

Processor speeds for supercomputers are moving beyond the billion-instruction-per-second range. With all this performance—and the promise for more—we really need ways to improve data-access times and data transfer rates between primary and secondary memory systems (i.e., RAM and disk).

However, no matter how creative the system architecture is, performance is always limited by how fast you can store (and retrieve) data. The limitations are the result of the seek and latency times that the mechanical nature of all disk drives—magnetic or optical—causes.

The problem is that disk drives are slow in comparison to present-day CPUs, even those used in personal computers. This situation is well known as the I/O bottleneck. Over the past 10 years, disk drive performance has increased by about a factor of three. In comparison, the CPU performance has increased by about a factor of 1000.

Computers designed with current processor technology require that you invest in sophisticated hardware and software disk-caching schemes to achieve quicker access to large volumes of data. However, disk caching does not provide significant speed improvements when you need random access to large data sets.

Another idea that was borrowed from the mainframe arena is the use of disk arrays. However, parallel access to eight disk drives only adds an order of magnitude improvement in performance.

Despite fantastic advances in magnetic and optical disk technologies, physical limitations are involved in getting data on and off these rotating devices. A top-of-the-line disk drive today can transfer 3 to 8 megabytes per second.

Enabling full-motion video editing and playback, for example, will require bandwidths greater than 20 MBps with current TV and personal computer standards. Further, high-definition TV requires four times the resolution of today's video programs and double the frame rate (60 frames per second instead of the current 30 frames per second).

What we need is a memory device that performs like RAM and has the capacity and cost of magnetic and optical media. The Optics Lab at Microelectronics and Computer Technology Corp. (MCC) is developing new techniques for storing

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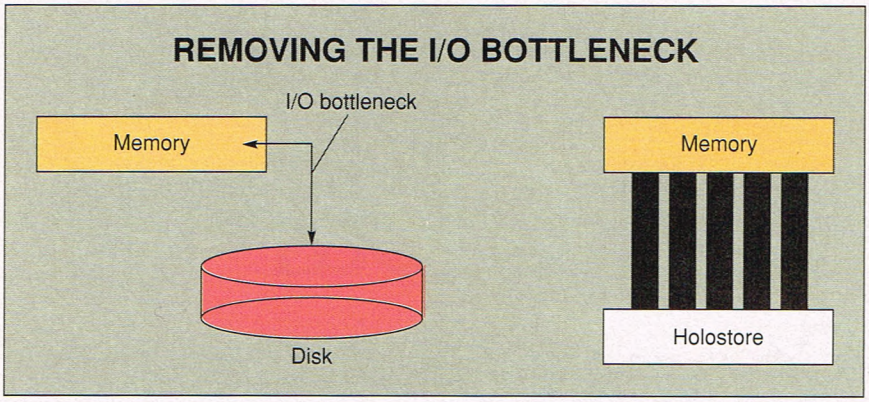


Figure 1: *The holostore is a new mass storage device that stores digital information as three-dimensional optical holograms. It could eliminate the I/O bottleneck.*

HOLOSTORE STORAGE CHARACTERISTICS

Table 1: *The characteristics of the holostore, both in the prototype device and in expected achievable targets, provide an overall view of its capabilities.*

Characteristics	Prototype targets	Achievable future targets
Page size	64K bits	1 megabit
Pages per stack	30 to 50	100
Stacks per module	900 to 2500	10,000
Storage module		
Size	3 by 3 by 0.5 cm to 5 by 5 by 0.5 cm	10 by 10 by 0.5 cm
Capacity	200 MB to 2 gigabytes	Over 100 gigabytes
Media	Fixed array of strontium barium niobate (3 cm by 0.5 cm)	Removable module
Average page read time	1 to 10 microseconds	100 nanoseconds
Average page write time	100 microseconds	10 microseconds
Average sustained transfer rate	100 to 800 MB per second	Over 1 terabyte per second
Costs	Prototype costs to be determined	Less than two times magnetic or optical disk cost per bit in 1995
Packaging	5¼-inch peripheral	Hybrid module

digital information as three-dimensional (3-D) optical holograms. The *holostore*, a new mass storage device with supercomputer performance, could eliminate the I/O bottleneck (see figure 1).

Storing and retrieving data as two-dimensional patterns of light, or *pages*, in a 3-D volume of light-sensitive crystal provides the basis for the holostore. Organizing the data into pages provides access speeds orders of magnitude faster than the rotating devices of today. For example, the fastest magnetic disk currently available takes over 5 hours to transfer what a holostore device could transfer in 1 second. Here, finally, is a memory device that can handle the demands of computing with images.

This technology is based on photorefractive volume holographic storage (PVHS) techniques; it makes possible extremely fast, nonvolatile, and potentially removable media. Holostore memory would be a good choice for systems that need to provide fast random access for the recording and playback of digital video and high-throughput transaction-processing systems. It could finally enable a secondary memory device to outperform the processor.

How It Works

Holostore is a name informally adopted for a memory device using holographic storage techniques that is capable of storing digital information as 3-D holograms in photorefractive crystals. To provide an overall view of the holostore's storage characteristics, table 1 shows its prototype targets and achievable future performance targets.

To optimize the device for a particular system (i.e., to the size of the blocks of data used), you can control page size, pages per crystallite (per stack), stacks per module, and whether modules are fixed or removable. A DOS- or Unix-based operating system would find a 4K-byte or 8K-byte page size easy to handle, since these choices closely map what disk drives provide today as a cluster. A holostore device embedded with custom processors for image processing may work more optimally with images sized to 512 by 512 bits, or 32K bytes. Record-oriented processing systems might perform better with smaller page sizes.

For illustrative purposes, let's assume the storage medium inside the holostore is an array of 2500 tiny crystal rods (50 by 50) tightly packed into a volume of 5 cm by 5 cm by 0.5 cm. This storage medium is small enough to need a special package to carry it. Initial prototypes expected in the next few years will be built to fit in a 5¼-inch form factor. The holostore's size will shrink considerably as solid optoelectronic technology matures, making it possible to integrate holostore technology directly into the processor.

The crystal storage material is strontium barium niobate doped with cerium to accelerate the photoelectronic activity during the write process. For details on the nondestructive read problems being solved for photorefractive crystals and the reason for using an array of crystallites instead of a single monolithic cube of photorefractive material, see the text box "Making PVHS Work" at right.

It has been demonstrated that each crystallite is capable of holding over 30 pages, but recent experiments indicate that 50 or more pages may be possible. One aerospace company demonstrated a prototype with lithium niobate crystals that could store 500 pages of information without signal-to-noise problems.

Reading and Writing

The holostore's major components are the laser source, the page composer or spatial light modulator, the crystallite array, the page-selector assembly, and the detector array (see figure 2). The laser light is split into separate beams and steered into the crystallite to write or read a page of data.

The holostore's laser source is a

Making PVHS Work

Photorefractive volume holographic storage (PVHS) technology has been investigated in the past as a memory-storage mechanism, but with little success. One reason for its failure was the emphasis placed on storage capacity. However, the real advantage of this technology is its random-access speed, which is fundamental and won't erode.

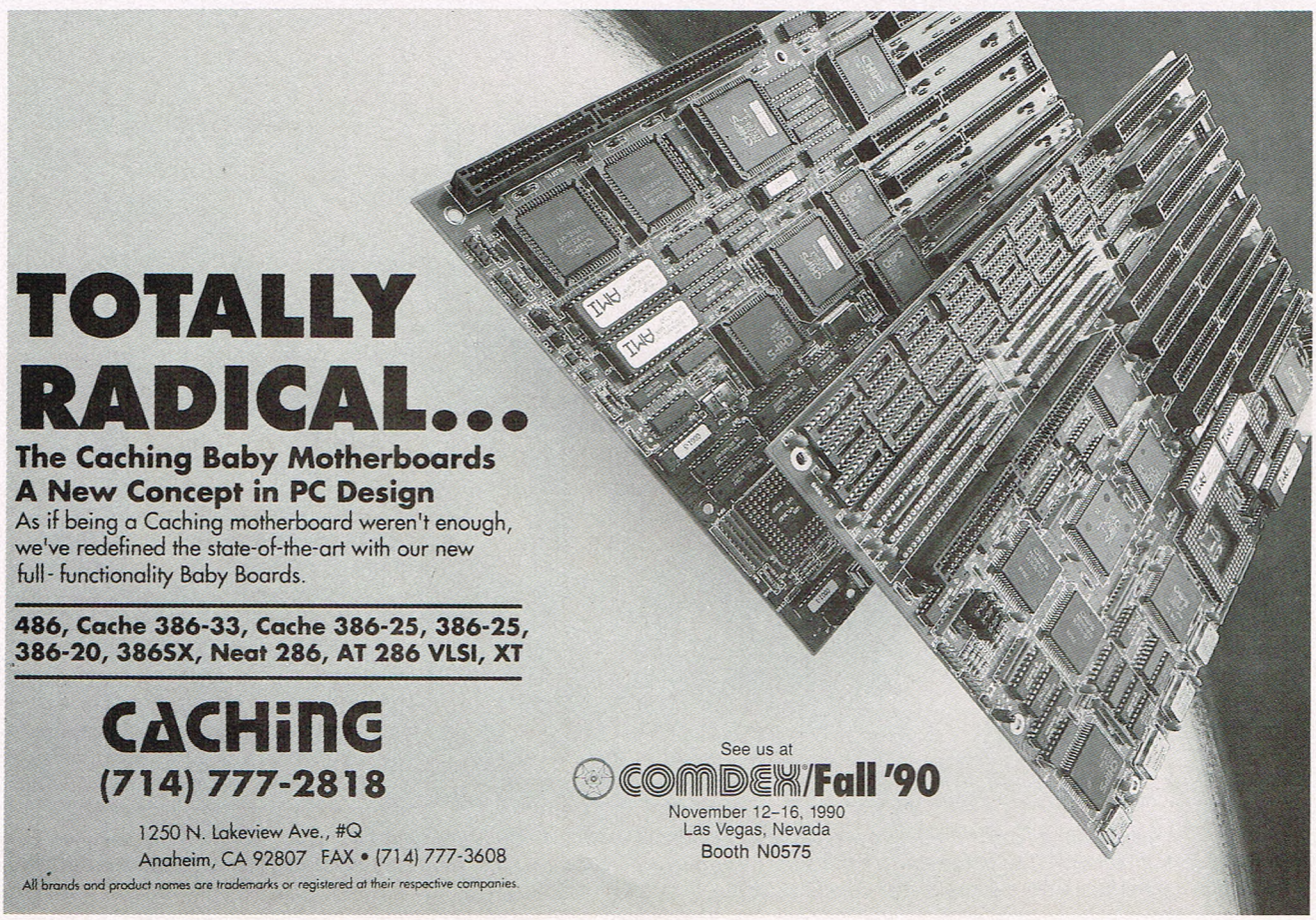
Another reason for early failures was the state of the art of related technologies (e.g., two-dimensional spatial light modulators as page composers, lasers, beam deflectors, photorefractive materials, and detector arrays). Only in the last few years has this technology been mature enough to put a prototype together at a reasonable cost.

One difficulty with PVHS technology has been its destructive readout. The reilluminated reference beam (i.e., the read beam) used to retrieve the recorded information also excites the donor electrons and disturbs the equilibrium of the space-charge field in a manner that gradually erases the recording. In other words, when you read a page from the crystal many times, eventually you destroy the information. In the past, this has limited the number of times you could read a page before the signal-to-noise ratio became too low.

Previously, bulk photorefractive crystals were usually used with relatively large crystals, usually 1 centimeter by 1 cm in length and 0.5 cm in depth. However, it is difficult to grow high-quality crystals, such as strontium barium niobate, in larger sizes, making scaling to higher capacity difficult. As a consequence, widespread application for bulk photorefractive technology did not occur, despite the initial surge of development in the 1970s.

In 1988, researchers at Microelectronics and Computer Technology Corp. (MCC) and Stanford University patented a nondestructive read technique and a manufacturing technique for using arrayed crystallites instead of monolithic crystals. The technique for the nondestructive read provides the ability for prolonged readout without degrading the stored image data. Tests have shown that the equivalent of one billion reads can be accomplished without signal-to-noise degradation.

Use of an array of crystallites, instead of a single monolithic crystal, has many advantages for holographic storage. Small-diameter crystals are easier to grow, and you can increase storage capacity by making a larger array. In addition, the reference beam is guided through the crystal rod, increasing the interaction length and thus the dynamic range. Also, these smaller crystals dramatically improve the angular selectivity of pages, allowing a larger number of pages per stack. And finally, they virtually eliminate cross talk between stacks.



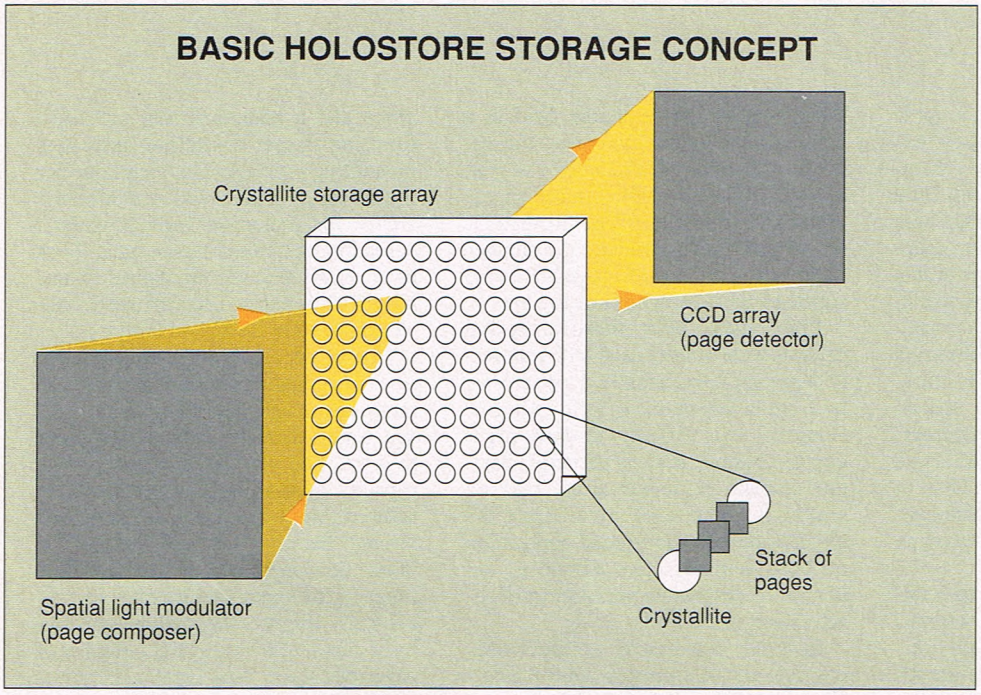


Figure 2: *The holostore superimposes a pattern of light and dark spots based on the digital data onto the data portion of the laser beam. The data is stored as electronic-charge patterns, based on the interference between the data and reference beams, which modify the optical properties of the crystallite. The result is a 3-D holographic image of the bit pattern carried in the data beam.*

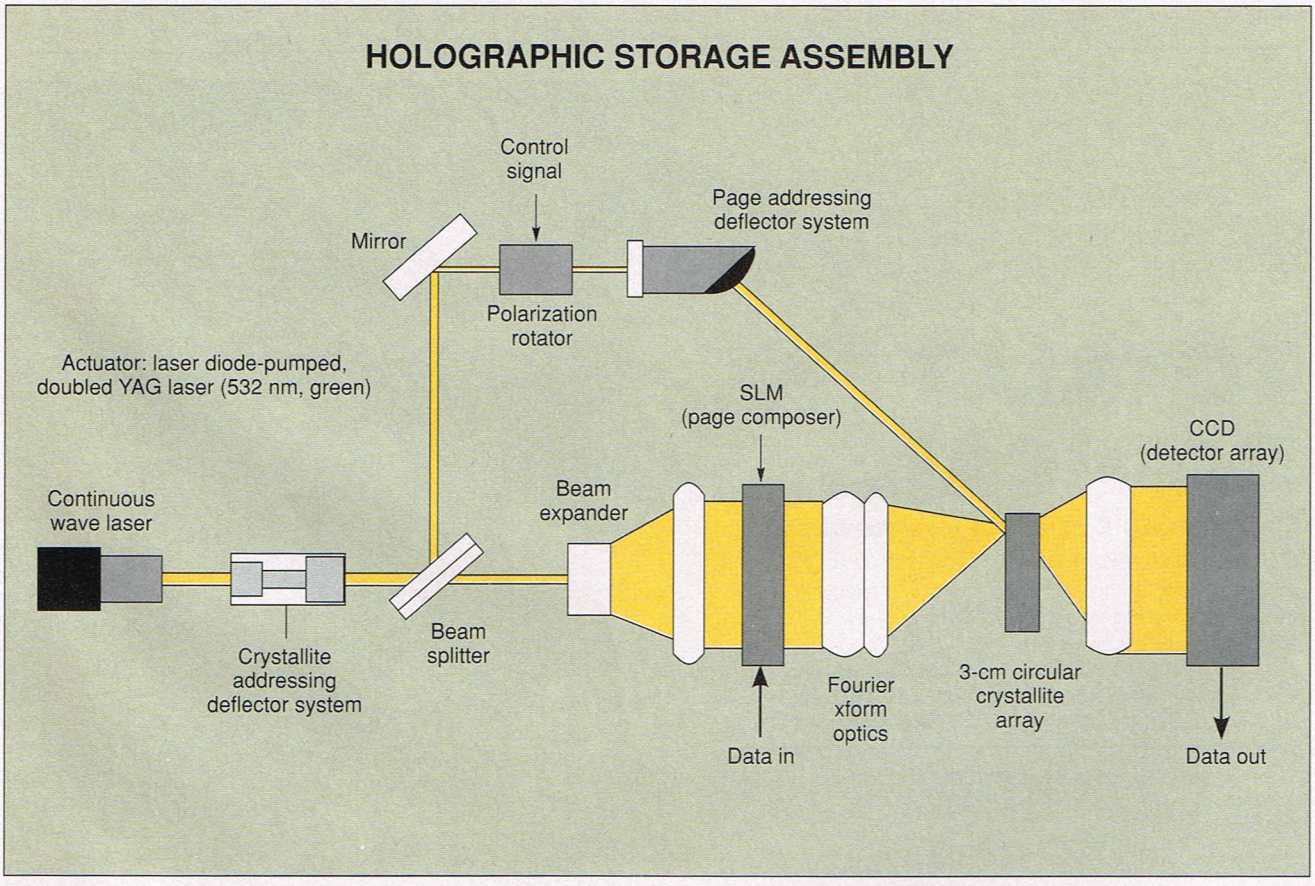


Figure 3: *The laser source for the holostore prototype is a compact, doubled, diode-pumped YAG laser with 80-milliwatt output at 532 nanometers. The beam splitter splits the laser into separate data and reference beams and steers them onto the surface of a crystallite to store (or retrieve) a page of data.*

compact, doubled, diode-pumped YAG (yttrium aluminum garnet) laser with 80-milliwatt output at 532 nanometers (see figure 3); a 532-nm laser falls within the green range on the visible spectrum (see the photo). Tracing the beam from the laser, it first encounters the stack-selector assembly, which steers it to an individual stack of pages. Next, a beam splitter separates the beam into two parts. The first part is the data beam, and the second is the reference beam.

Starting from the beam splitter, the holostore expands the data beam onto the surface of the page composer, where digital electronic data enters the system. This data is displayed on the surface of the page composer and illuminated by the expanded data beam, creating a bit pattern of light and dark spots. The holostore superimposes this pattern of spots based on the digital data onto the laser beam, where it represents the bits on the page to be stored.

After the page composer, the holostore focuses the data beam through a lens system into and through the crystallite array. As the two beams, data and reference, enter the crystallite together, the reference beam interferes with the data beam, writing an interference grating in the photorefractive material. The holostore converts the grating pattern in the photorefractive material to a stored electronic-charge pattern that modifies the optical properties of the crystallite.

The result is a 3-D holographic image of the bit pattern carried in the data beam. (The interference grating allows the hologram to be recreated when the holostore reads the data.) This is the entire write process.

As an example, a 256- by 256-bit array (8K bytes) should require approximately 100 microseconds to transfer, assuming a theoretical transfer rate of 80 MBps. Currently, the frame rate of the page composer limits the I/O rates. To write another 64K-bit page in the same stack, the holostore shifts the reference beam's angle roughly one-fourth of a degree and loads new data on the page composer.

The read cycle is relatively simple. During a read cycle, the data beam is shut off, so only the reference beam shines through. The holostore selects the location of the reference beam for the specific stack of pages to be read, and the angle then determines the address of the specific page in that stack.

The reference beam illuminates the interference grating stored at this selected angle, resulting in the reconstructed image of the original bit pattern stored there. The holostore then focuses this pattern as an image on the system's detector array. The detector array is a charge-coupled device that captures the reconstructed light and dark bit patterns of the image and converts them back to digital electronic signals for transfer to the computer.

An average page-access time of 1 microsecond has been demonstrated with the prototype now under development at MCC, which provides a potential transfer rate of 800 MB per second. In the future, even higher speeds should be available as computers are reoriented toward high-performance memory devices.

Staging the Technology

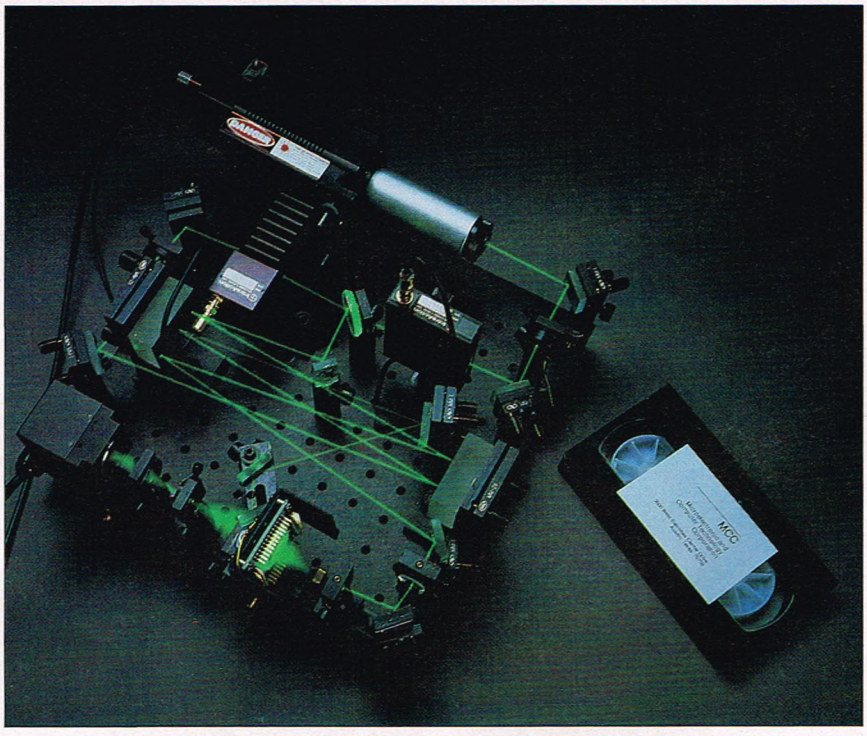
Getting the holostore into personal computers and workstations will come in stages. Some possible areas of application are disk replacement, disk caching, front-end-processor caching, system-bus interfacing, and direct connection to the CPU. These areas are listed in order of their complexity to implement, as this will have an effect on how soon holostore devices for these functions will appear.

It's easy to affect computer performance by installing a holostore device as an interface to existing ESDI, SCSI, or SMD controllers in installed systems. This would require no changes to bus structure or the operating system, although it might be necessary to modify disk drive controller firmware somewhat. To the controller, the holostore device would look exactly like a disk drive without seek and latency delays. When data is requested, it is available at whatever transfer rate the existing controller can support.

Performance improvements of two to 30 times for workstations are possible because the holostore would greatly reduce seek and latency times. (It would provide 1- to 10-microsecond access time versus approximately a 10-millisecond access time for magnetic or optical disk storage.) The holostore would provide a simple way to boost the performance of installed systems through field upgrades. It could also provide freedom from the vibration and temperature problems that trouble disk drives.

Where a large investment in minicomputer and network-based disk systems exists, you might want to upgrade only the disk-caching component. After all, the processors have the performance you want; it's the disk drives that create the bottleneck.

A new caching disk drive controller with a few hundred megabytes of extremely fast nonvolatile holographic storage would boost the performance of existing drives by holding "hot spots" in



A prototype holostore device. Since the beam falls within the green range on the visible spectrum, you can trace its progress through the device (see figure 3 for more details).

HOLOSTORE APPLICATIONS

Table 2: *Many possible applications for the holostore come to mind because of its ability to handle the demands of high bandwidth at a relatively low cost with a nonvolatile memory system.*

Memory-hierarchy element
Special virtual memory paging devices
High-speed write-through cache
Context swap space
Plug-compatible disk drive replacement
"Solid-state disk" for "hot spots" in databases
"Bulk-store" swapping device for transaction processing and supercomputing
Removable medium for data backup and high-speed restore

Image-processing element
Diagnostic-medicine image store
Target-classifier subsystem
Airborne sensory-data recorder
Vehicle data-storage system

Entertainment medium
"Crystal jukebox" for music and video
High-definition TV video recorder
Read-only movie-playback system

Data-distribution medium
Compact, nonvolatile, random-access replacement for microfiche and CD-ROM

databases, and simplifying recovery and restart issues for transaction-processing systems. This same holostore (disk-caching controller) could provide a port for removable backup and high-speed restore.

Another possibility for improving the throughput in transaction-processing systems is to integrate a multimegabyte, nonvolatile holostore device into a front-end processor or file server. This would allow the front-end processor to run more independently during main-system interruptions, and would vastly simplify recovery and restart.

A holostore device could also be integrated onto the system bus as the primary memory device, which would give you "instant on" support for playing back audio, video, and text files.

Finally, the most fascinating designs with holostore devices will be those integrated directly into the CPU for image-processing applications. The holostore can provide quick random access to extremely large files with no bus delays, an important factor for high-performance graphics workstations and multimedia systems' controllers.

Interactive Video

One popular vision for the future includes full interactive-video applications working as smoothly and quickly as text applications do today. To achieve this vision, you need the ability to record and play back hours of digital video as well as edit the programs in real time. Instant access to video and audio would also decrease the amount of time that professionals currently have to spend to edit and produce video programs.

Current optical and magnetic disk drives aren't built to achieve these visions. You may recall the problems that the budding digital video interactive (DVI) industry has had to overcome to permit CD-ROMs to play back digital video on existing 286/386 systems. Sophisticated compression and decompression algorithms are being designed into special ICs to overcome two problems: insufficient data storage and I/O speeds.

NTSC-standard TV supports a screen resolution of 512 by 480 pixels. You need at least 750K bytes of data to display a single frame. To get the full-motion effect you see on TV, the screen must display 30 frames per second; hence, the bandwidth requirement for playing video is 22.5 MBps. Without precompressing the video into presentation-level video, a CD-ROM of 648 MB would hold less than 30 seconds of video and take more than an hour to show.

Most scenes don't change dramatically from one frame to another. Thus, DVI developers have devised a compression algorithm that digitizes and stores the first frame of a scene, and then stores only the changes in the scene from frame to frame.

Playing back a video application is made possible by moving the compressed data over the I/O path from the disk drive to special decompression hardware. As the CD-ROM can provide 72 minutes of full-motion video, it will undoubtedly become a common video playback device, much like the audio CD has.

In the Crystal Ball

Most of the cost in any computer-related product is the memory component. The cost of RAM, ROM, and disks dominates current products, and with the move to more digital, audio, and video capabilities and the increases in storage that they require, these costs will rise.

The holostore could be the next piece in the hierarchy of memory devices between RAM and disk drives to support the growing demands of high bandwidth, low cost, and, most important, nonvolatile memory systems. Table 2 contains some possible holostore applications.

With the growing emphasis on high-resolution video and graphics merged with high-fidelity audio, the holostore could be a major weapon in the arsenal of high-speed I/O devices—one that can support the high bandwidth that these digital products require. ■

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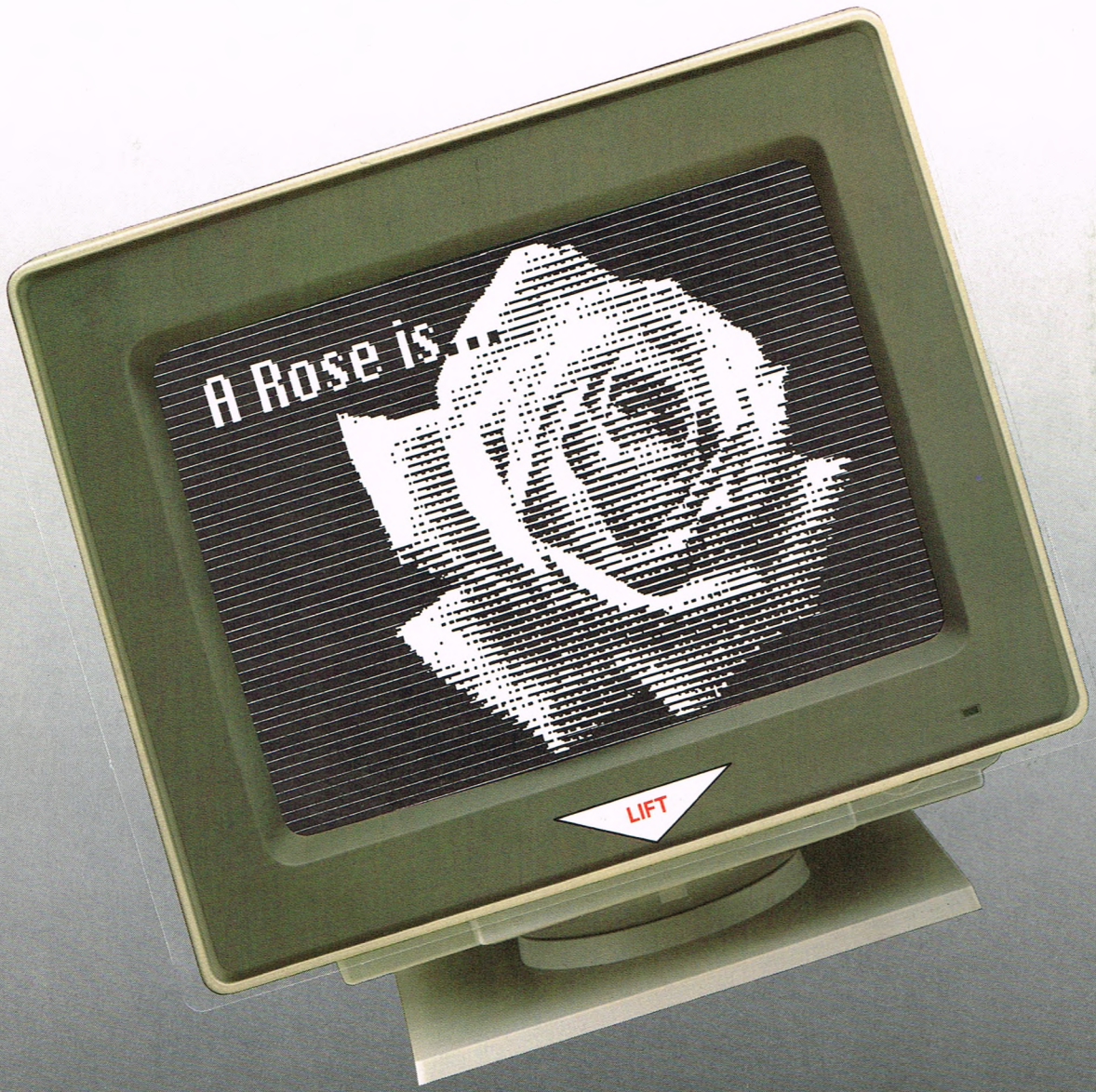
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ACKNOWLEDGMENT

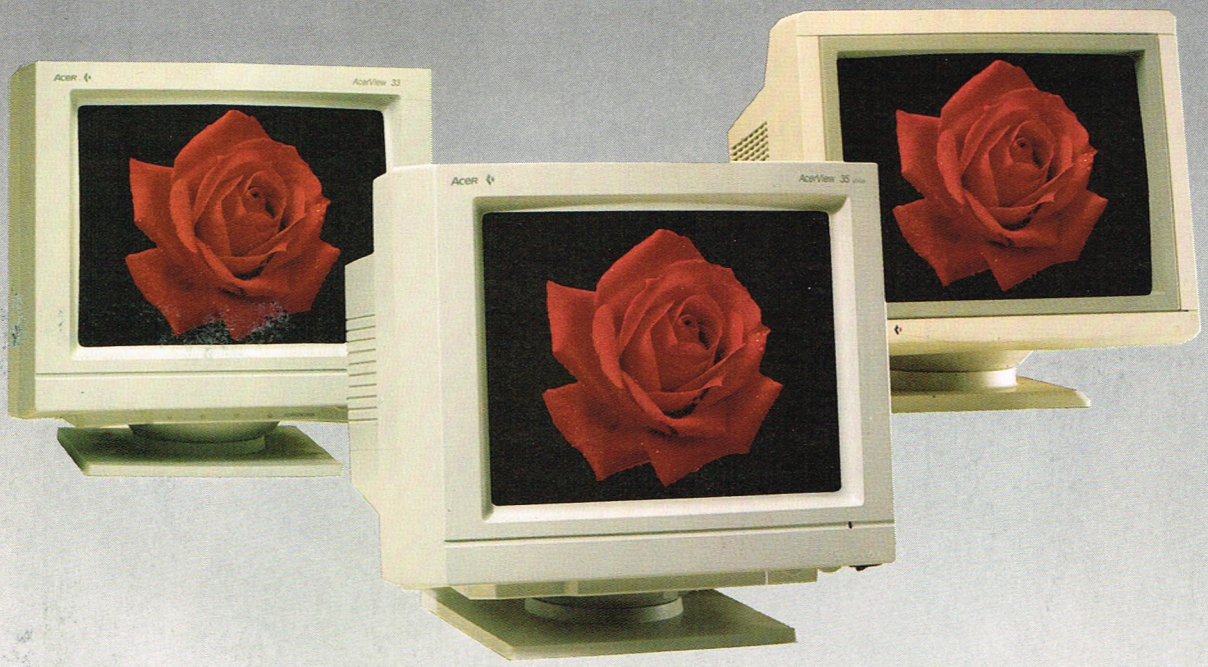
Special thanks to Ron Riedesel, Steve Redfield, and Jerry Willenbring from the Optics Lab at MCC, and John Pinkston, chief scientist. MCC holds a patent on holostore devices.

Tom Parish is a senior technical advisor for MCC (Austin, TX). You can reach him on BIX c/o "editors."



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Entering a New Phase

Phase-change technology combines the capacity of magneto-optical storage with enhanced performance

Bob Ryan



Optical and magnetic storage represent opposite ends of the spectrum. Optical storage is volume storage, while magnetic media offer performance.

With the capacities of individual, replaceable cartridges measured in hundreds of megabytes and gigabytes, optical disks let you store amazing amounts of information in machine-readable form. On the other hand, with access times heading below 10 milliseconds and throughput well over 10 megabits per second, magnetic media remain the only choice for applications where superior disk performance is essential.

Now, by combining the capacity of magneto-optical (MO) storage with enhanced performance, a new optical storage technology—rewritable phase change—promises to make the gap between optical and magnetic storage seem more like a crack in the sidewalk and less like the Grand Canyon.

A New Arrival

Phase-change technology has existed since the 1960s and is used in many commercial WORM (write once, read many times) drives. Up to now, however, technical concerns about media durability have kept rewritable phase-change storage devices in the research labs and off your dealer's shelves. With the introduction of rewritable phase-change drives in this country and Japan by Matsushita, the technology has made the transition from theory to reality.

Phase-change technology is the first read/write optical storage technology that allows for the direct overwriting of old data by new. This gives phase change a big advantage over current read/write optical disks, which are based on MO technology.

Erasable Optical Today

As the name implies, magneto-optical disk drives are a combination of magnetic and optical technologies. Unlike purely optical technologies, such as CD-ROM, WORM, and rewritable phase change, MO systems depend on both magnetism and optics to store and retrieve data.

MO drives have made their mark as the first commercially viable erasable optical technology, but limitations in the technology may make it little more than a transition from pure magnetic systems to pure optical ones.

A successful storage technology must be able to create either an "on" or an "off" condition at a particular area—the recording spot—on the recording medium and be able to differentiate between these two conditions. In addition, a read/write technology must be able to change a recording spot from the "on" condition to the "off," and from the "off" to the "on." Like magnetic media, MO systems fulfill all the

ILLUSTRATION: JOE GAST © 1990

requirements of true read/ write systems. The problem comes from *how* they fulfill the requirements.

MO disks are built from layers of materials. These layers are built on a glass or polycarbonate substrate, which carries the grooves and other formatting marks. The active recording layer, consisting of a rare-earth, transition-metal alloy, is normally sandwiched between two other layers that enhance the effects of the "read" laser beam. The two enhancement layers also protect the active layer from contaminants. Capping off the disk is a transparent surface layer.

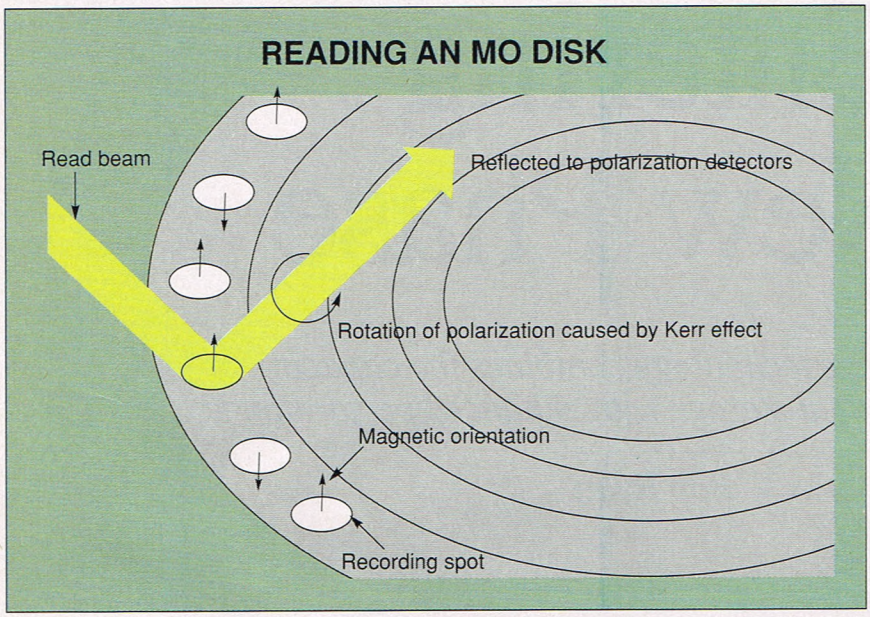


Figure 1: *Every recording spot on a magneto-optical disk has a magnetic orientation that corresponds to either a 0 or a 1. To determine the orientation of a spot, the read system bounces a low-power laser off the spot. The direction of the polarization rotation put on the reflected beam by the spot's magnetic orientation reveals whether the spot is a 0 or a 1.*

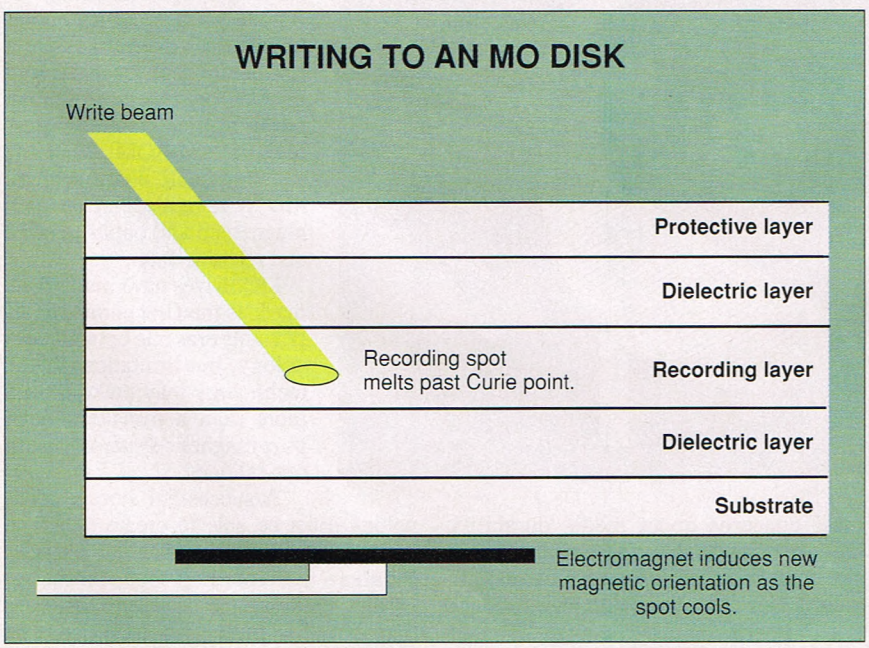


Figure 2: *Writing a bit to a magneto-optical disk means setting the magnetic orientation of a recording spot. The write laser melts the spot, while the underlying magnet produces a field with the new orientation of the spot. As the spot cools, it assumes this new orientation.*

The active layer of an MO disk is always magnetized. A magnetic surface affects the polarization of any light that reflects off it by rotating the polarization of the light either clockwise or counterclockwise. This is called the *Kerr effect*. The direction of this rotation depends on the magnetic orientation of the reflective surface.

A recording spot on an MO disk can have one of two magnetic states: positive or negative. These correspond to binary 0s and 1s. The optical head determines whether a spot is a 0 or a 1 by analyzing how the beam of a low-power "read" laser is polarized when it is reflected off the spot. Negative Kerr rotation corresponds to one state; positive rotation to the other. Thus, MO drives fulfill the first criterion of a useful read/write technology: the ability to determine the "on" or "off" state of a particular spot on the recording medium (see figure 1).

The second criterion—changing a spot from a 1 to a 0 or from a 0 to a 1—involves changing the magnetic orientation of a spot. This, in turn, involves the precise synchronization of optical and magnetic technologies.

Magnets and Mirrors

To write to an MO disk, you have to be able to change the magnetic orientation of a spot without affecting the nearby spots. This is the function of the powerful "write" laser.

This laser has one purpose: to heat a spot on the recording medium to the Curie point—the temperature at which a magnetized substance loses its magnetic orientation. Once a spot is heated to the Curie point, a small electromagnet on the side of the disk opposite the read/ write head generates a magnetic field that reflects the new orientation of the spot. As the spot cools past the Curie point, it assumes the orientation of this magnetic field (see figure 2).

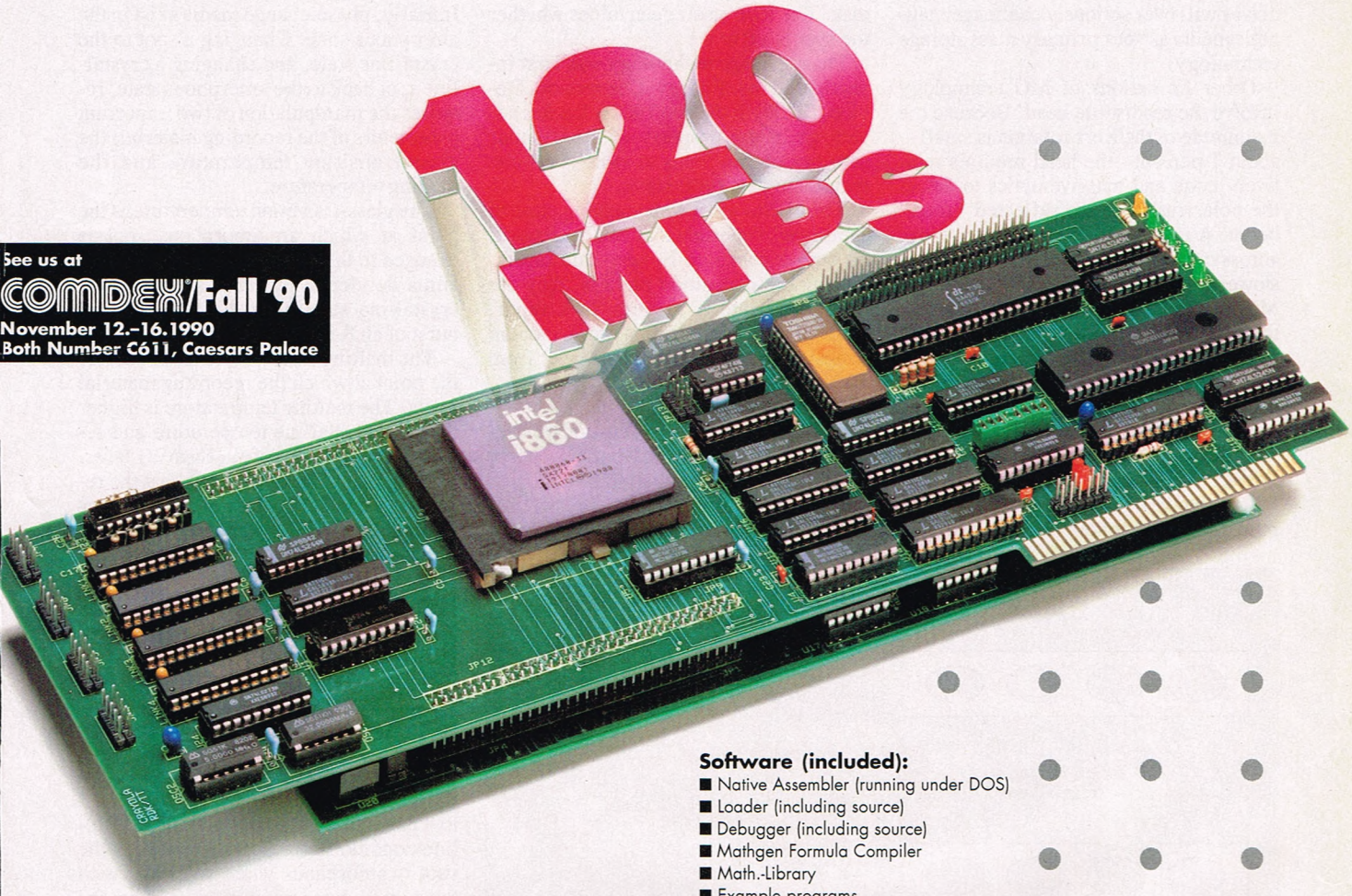
When an MO disk is manufactured, every spot on the recording layer has the same magnetic orientation. This is the default condition of the media. Whenever an MO drive writes to the medium, it assumes that whatever area it writes to is in the default condition. Thus, before writing any data, an MO drive must first erase the area of the disk it wants to write to. Erasing a spot brings its magnetic state back to the default condition.

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- Loader (including source)
- Debugger (including source)
- Mathgen Formula Compiler
- Math.-Library
- Example programs
- Demonstration program

Software (optional):

- Intel i860-Macro-Assembler
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- C-Compiler[1)]
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to it effectively doubles the write time of MO drives in relation to other read/write storage technologies. This performance handicap makes it unlikely that MO drives will ever seriously challenge magnetic media as your primary mass storage technology.

Other limitations of MO technology involve the read/write head. Because the magnitude of the Kerr rotation is small—about 1 percent—the head requires relatively large and massive optics to detect the polarization of the reflected "read" beam. A massive head is slower to move across the surface of the disk, resulting in slower access times. Therefore, although MO disks spin as fast as magnetic media, the performance of the drives is two to four times slower than magnetic drives in read/write operations, and as much as six times slower in accessing a particular spot on the disk.

Direct Write

Phase-change optical storage systems are pure optical technologies. Unlike MO systems, where the "write" laser merely prepares the recording surface for the data, the "write" laser of a phase-change system actually writes the data to the disk. The laser itself determines whether the spot is a 0 or a 1.

Phase-change technology was first investigated by Energy Conversion Devices (ECD) in the late 1960s. It takes advantage of the property of a particular category of thin films to switch between two stable structural states.

Thin films are a wide-ranging class of semimetal materials that can be deposited onto a substrate in very thin layers. During the deposition process, they are introduced into a vacuum as a vapor. With phase-change thin films, vacuum deposition results in an active layer from 200 to 500 angstroms thick.

The compounds used in phase-change thin films are based on tellurium or selenium. These elements have the property of exhibiting both an amorphous state and a crystalline state. You can switch a spot in the recording layer between these two states by the judicious application of power from a laser.

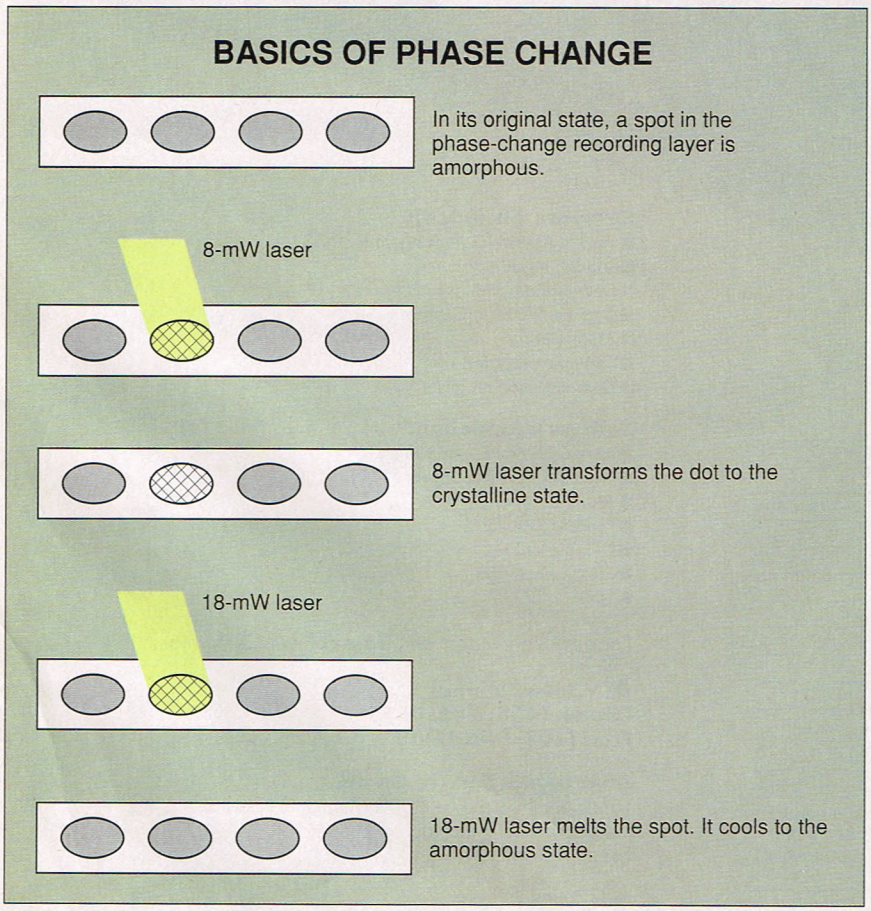


Figure 3: *The remarkable property of phase-change media to change from amorphous to crystalline at one energy level and from crystalline to amorphous at a higher level enables the realization of direct optical overwrite.*

There and Back Again

Initially, phase-change media exist in the amorphous state. Changing a spot to the crystalline state, and changing a crystalline spot back to the amorphous state, requires the manipulation of two important parameters of the recording material: the glass-transition temperature and the melting temperature.

The glass-transition temperature is the point at which an amorphous spot is changed to the crystalline state. The thin films developed by ECD switch to the crystalline state when hit with a short burst of an 8-milliwatt laser.

The melting temperature is, of course, the point at which the recording material melts. The melting temperature is higher than the crystalline temperature and requires a more powerful (18-mW) laser. The important feature here is that the recording material doesn't recrystallize as it cools from the melting temperature; rather, it cools into the amorphous state. This process, called *revitrification*, gives the phase-change media the ability to switch directly from amorphous to crystalline and back again. Direct an 8-mW laser at a spot, and it turns the spot crystalline; use an 18-mW laser, and the spot becomes amorphous (see figure 3).

Note that the original condition of the spot is immaterial to the results of the write operation. Say you want to write a 1 to a particular spot, and that the crystalline condition corresponds to a 1. If the spot is amorphous when you hit it with the 8-mW laser, it will change to the crystalline form. If the spot is already crystalline when you hit it with the 8-mW laser, it will remain crystalline, because the laser isn't powerful enough to melt it.

Likewise, when you want to write a 0, the higher-powered laser will always melt the recording material and return it to the amorphous state, regardless of whether it was amorphous or crystalline to begin with.

Reading Material

The ability to change directly from one state to another is critical to a one-step read/write technology, but equally important is the ability of the system to distinguish between the two states. Luckily, the amorphous and crystalline states differ in a very fundamental optical characteristic—they exhibit different reflectivities. The system determines whether a spot is a 0 or a 1 by examining the intensity with which the spot reflects a low-

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power "read" laser (see figure 4).

Because the differences in reflectivity between the amorphous and crystalline states of phase-change media can be orders of magnitude greater than the 1 percent change in Kerr rotation detected by MO systems, the read/write heads of phase-change systems don't have to be as sophisticated and sensitive as those of MO drives. Thus, as the technology matures, you should see phase-change read/write heads become less massive than their MO counterparts. The result will be faster seek and access times.

The Layered Approach

Like an MO disk, a phase-change disk consists of more than a substrate and a recording layer. Further layers are usually added to enhance the contrast between the reflectivity of the two states and to protect the active layer from outside contaminants.

Tellurium, the primary material used in most phase-change media, crystallizes below room temperature in its pure form, making it impossible to use in an everyday office environment. However, the introduction of small quantities of other materials, such as germanium and antimony, raises the glass-transition temperature of the alloy above 100 °C.

Future Phases

After two decades in R&D laboratories, phase-change storage devices are now available from Matsushita in both Japan and the U.S., where they are marketed under the Panasonic brand name (see the text box "Phase Change Is Real" on page 296). As more manufacturers introduce phase-change systems and as researchers make advances in media and optical-head technologies, you will see a steady improvement in media durability and disk access speeds. Given its inherent advantage over MO technology, phase-change storage may be the premier optical storage technology by the middle of the 1990s.

In the future, phase-change technology may also challenge magnetic media in all but the most speed-intensive applications. Advances such as very small integrated optical read/write heads will greatly decrease access times, and more durable media will silence doubts about the reliability of the technology. Given its already large advantage in costs per K byte of storage, phase change may be the

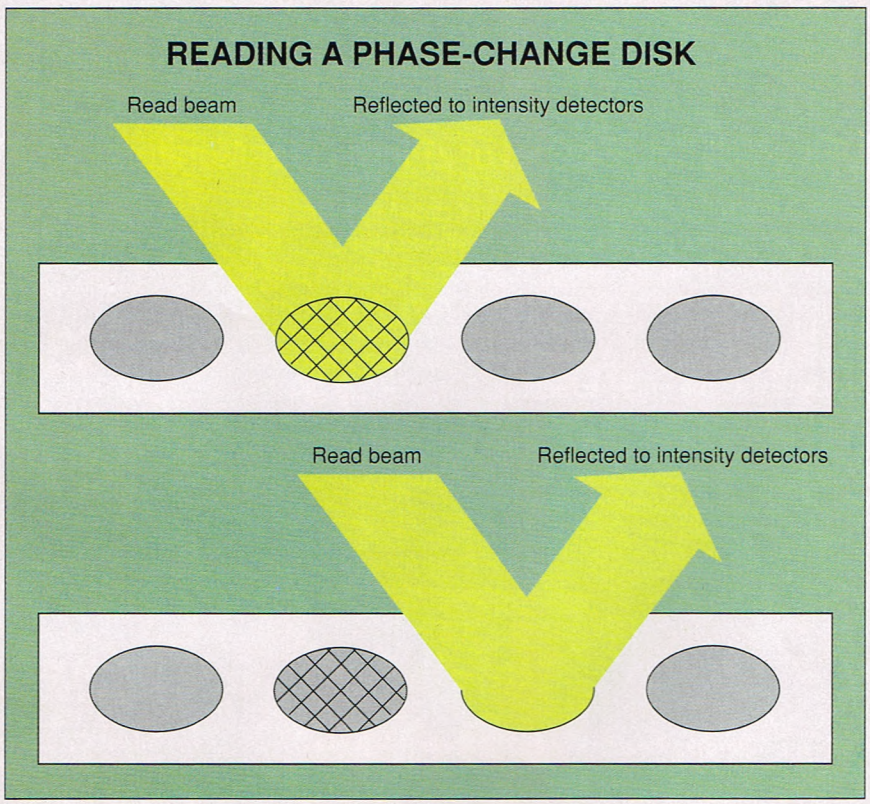
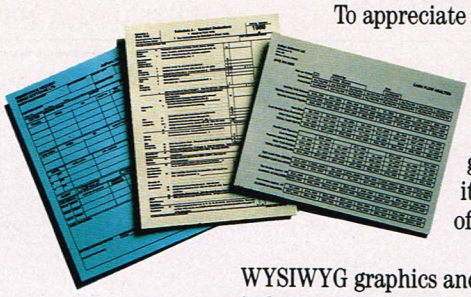


Figure 4: *Unlike magneto-optical drives, which must detect small changes in the read beam's polarization, phase-change systems read information by detecting the relatively large differences in the reflectivity of the amorphous and crystalline states.*

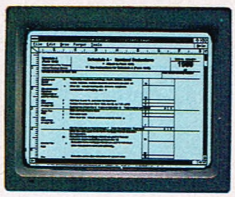
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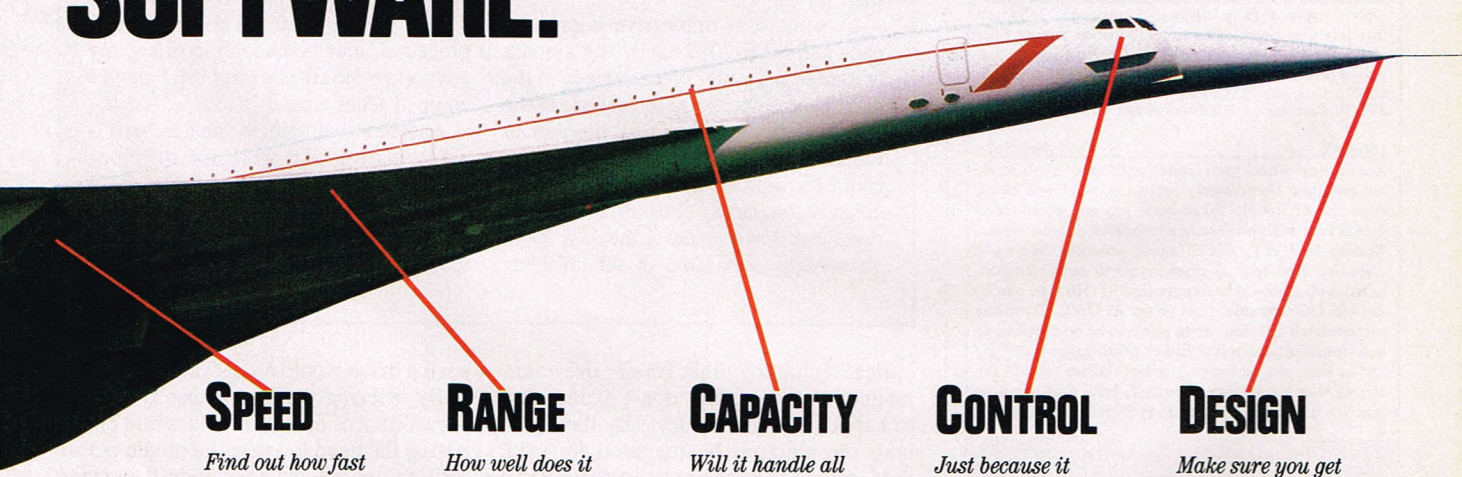


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Phase Change Is Real

This spring, Panasonic Communication & Systems Co. introduced the LF-7010, the first phase-change optical storage system available in the U.S. The LF-7010 is a multifunction drive, capable of reading and writing Panasonic's current WORM media as well as its own phase-change disks.

The LF-7010 uses 5¼-inch media to store 1 gigabyte of information on a single phase-change media cartridge. The drive can also read and write (once) the 5¼-inch medium that Panasonic's LF-5010 WORM drive uses. This medium stores 940 megabytes on each cartridge. Panasonic plans to install the LF-7010 into an automatic cartridge changer—a "jukebox"—that will hold up to 50 phase-change and WORM disks for a maximum capacity of 50 gigabytes.

Pluses and Minuses

This phase-change system features a data transfer rate to and from the disk that can reach 10.3 MB per second. It uses the SCSI-2 interface, making it compatible with an ever-widening range of computer hardware. Panasonic rates it with a mean time between failures of 20,000 hours and a bit-error rate of less than 10^{-12}.

To achieve its impressive storage capacity, the LF-7010 varies the amount of data that it stores on each track of the disk. Longer tracks on the outside of the disk contain more data than the shorter tracks on the inside. This provides more room for data on the disk, but the increased complexity of the disk organization slows down access to the data. With an average seek time of 90 milliseconds, the LF-7010 is fast by WORM standards, but 50 percent slower than some magneto-optical (MO) drives and nearly 10 times slower than a high-performance hard disk drive. Obviously, the LF-7010 isn't ready to become your primary mass storage device.

Choosing the appropriate balance between capacity and access speed is a decision every optical-drive manufacturer must make. Panasonic intends the LF-7010 for applications, such as document-image retrieval and archival storage, that put a premium on capacity as opposed to speed. Therefore, it made sense to go with a system that varies the amount of data per track to take advantage of the longer tracks on the outside of the disk. There is nothing to prevent Panasonic from coming out with a faster drive that stores a fixed amount of data per track, although such a system probably wouldn't be compatible with current WORM and phase-change media.

Battle Joined

Obviously, the LF-7010 can't compete with magnetic media as a primary storage technology. However, MO developers—even those who emphasize access speed over capacity—will have to take note of the LF-7010. Its one-pass write procedure may be enough to offset any advantage small-capacity MO drives enjoy in access speed.

As a new technology, the LF-7010 is a fascinating and welcome development. In the marketplace, though, it won't be judged on the sophistication of its innards but on the job it does for users.

optical technology that finally overtakes magnetic storage. But don't expect that to happen in this century. (By then, you may see electron beams used to write data instead of laser beams, resulting in a significant increase in the storage density of the media.)

Perhaps the most important aspect of phase-change technology is that it uses the same read method used in CD-ROM and WORM systems. This will make it possible to build multifunction optical drives that can read three of the four types of optical storage media—MO is the exception—and write to both WORM and phase-change disks. The benefits of such a drive would be enormous.

By offering the high capacity and removability of optical media while eliminating the need to erase the media before writing, phase change holds a definite theoretical advantage over MO storage. It remains to be seen whether Matsushita and others can translate this advantage into superior products. However, the next few years will be a banner time for the consumers of optical storage devices as these contending technologies are pushed to their limits. ■

Bob Ryan is a BYTE technical editor. You can reach him on BIX as "b.ryan."

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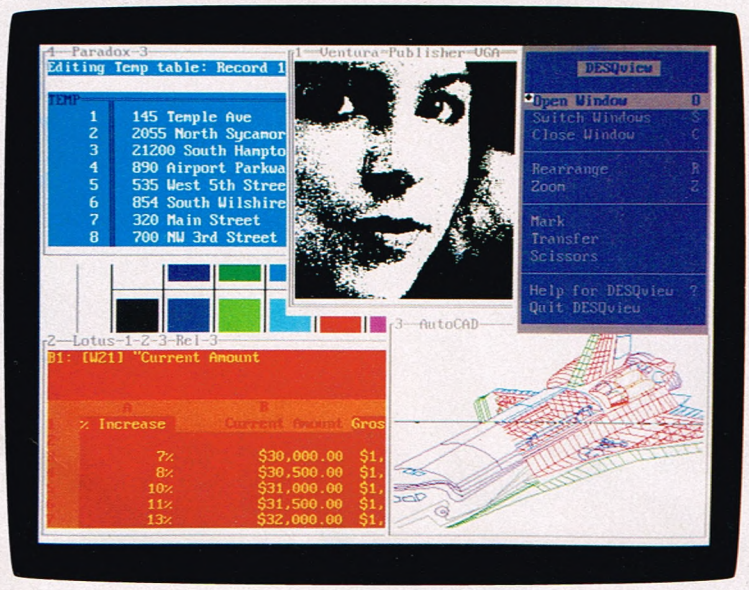
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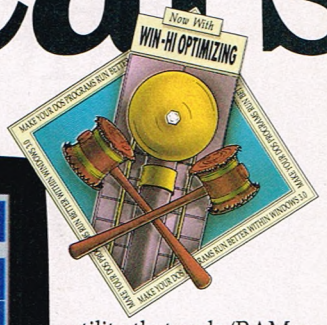
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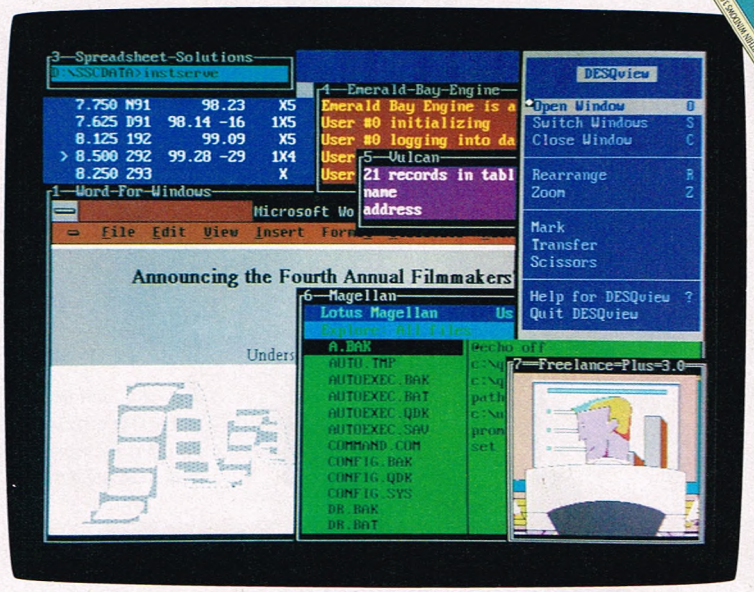
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DESQview System Requirements: IBM Personal Computer and 100% compatibles (with 8086, 8088, 80286, 80386 or i486 processors) with monochrome or color display; IBM Personal System/2 • Memory: 640K recommended; for DESQview itself 0-145K • Expanded Memory (Optional): expanded memory boards compatible with the Intel AboveBoard; enhanced expanded memory boards compatible with the AST RAMpage; EMS 4.0 expanded memory boards • Disk: two diskette drives or one diskette drive and a hard disk • Graphics Card (Optional): Hercules, IBM Color/Graphics (CGA). IBM Enhanced Graphics (EGA), IBM PS/2 Advanced Graphics (VGA) • Mouse (Optional): Mouse Systems, Microsoft and compatibles • Modem for Auto-Dialer (Optional): Hayes or compatible • Operating System: PC-DOS 2.0-4.0; MS-DOS 2.0-4.0 • Software: Most PC-DOS and MS-DOS application programs; programs specific to Microsoft Windows 1.03-3.0, GEM 1.1-3.0, IBM TopView 1.1 • Media: DESQview is available on either 5-1/4" or 3-1/2" floppy diskette.

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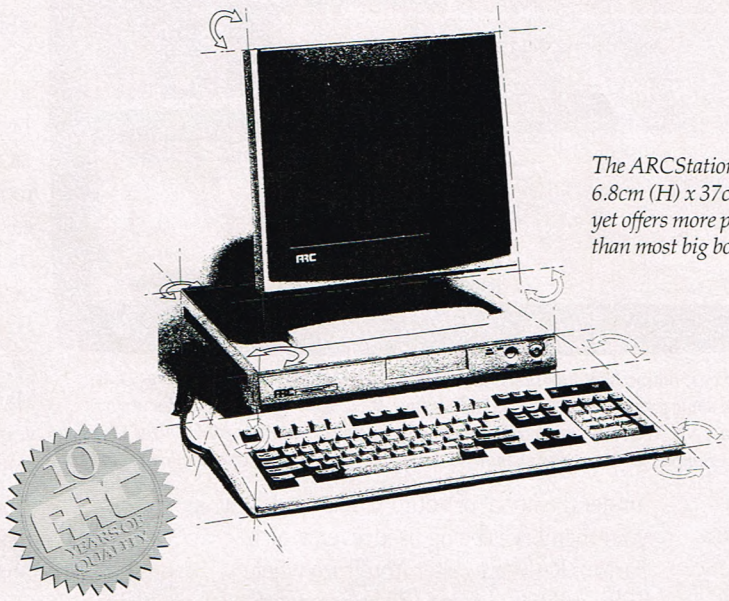
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Finland	52-609100	Norway	42-12560	Sri Lanka	1-574980	West Germany	40-660051
France	1-470-93636	Pakistan	21-521-529	Sweden	31-658-551	Yemen Arab Republic	2-207721
Greece	1-361-3500	Papua New Guinea	257-477	Switzerland	22-785-1000		
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The Once and Future King

Hard disk technology: Reports of its death have been greatly exaggerated

Bob Ryan

In Greek mythology, Odysseus had to sail a fine line between Charybdis and Scylla. Today, the same can be said about hard disk technology, as it tries to maintain a viable position between solid-state and optical technologies. A safe course depends on the continued evolution of materials, recording methods, and storage subsystems.

Solid-state storage has a speed advantage over hard disk drives, and optical disks are capable of storing more data. With the continued improvement in speed, capacity, and price/performance ratio, hard disk drives can still remain the preferred direct-access storage devices. The challenges, however, are formidable.

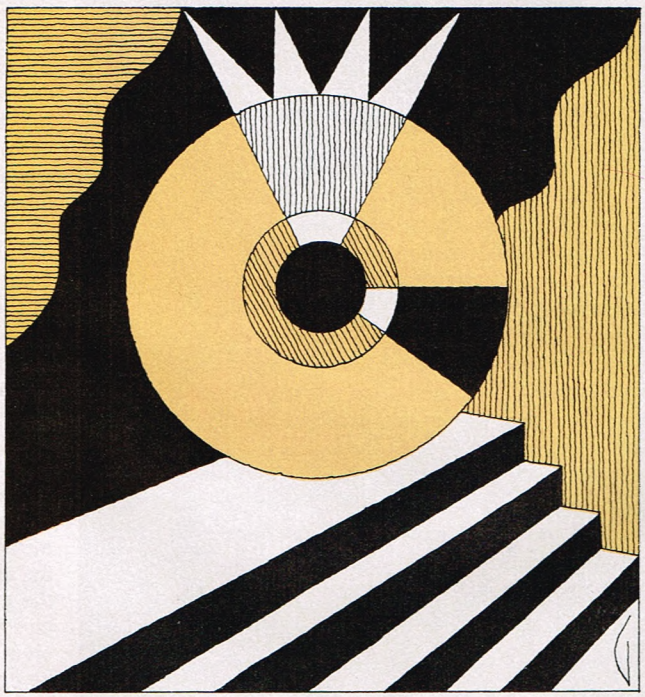


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The Contenders

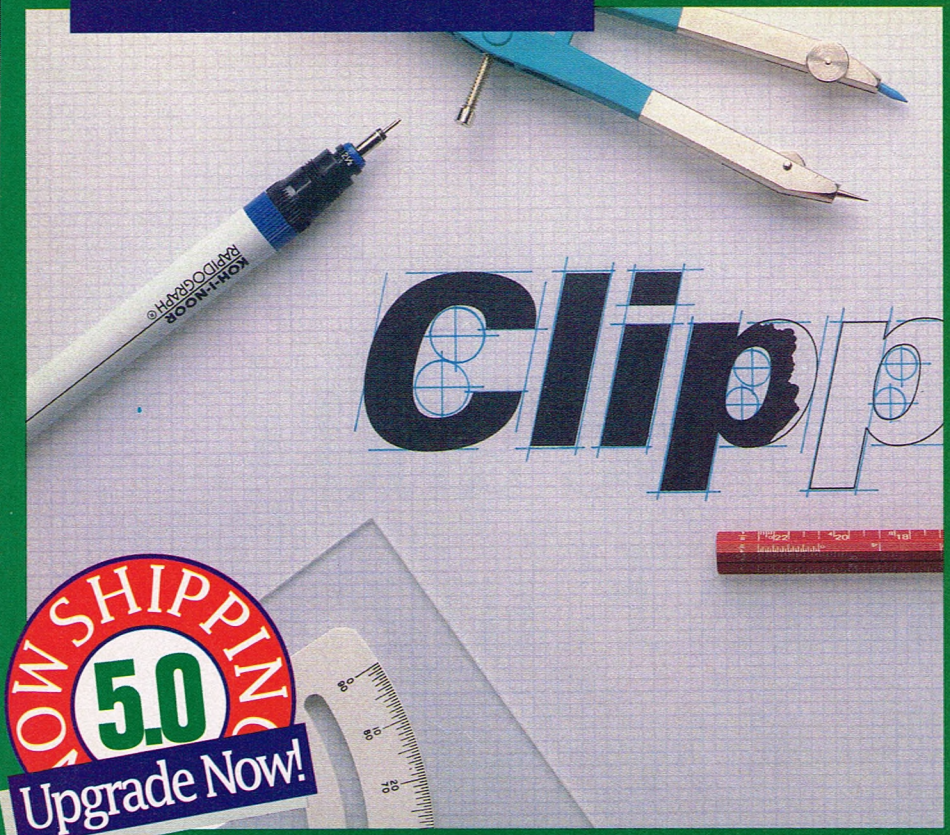
The idea of using memory chips for direct-access storage is not a new one. Dedicating a portion of memory to a RAM disk is a well-known way to increase system performance for disk-intensive activities. In fact, some companies in the early to mid-1980s were quite successful selling RAM disk expansion boards for IBM PCs and Apple IIs. These products were not meant to replace magnetic storage; you always had to copy the data they contained to a magnetic disk before you powered down your computer.

Newer forms of semiconductor mass storage *are* intended to replace disk storage. As DRAM densities climb to the 4-megabit and 16-Mb levels and as the cost per bit drops, it becomes practical to construct mass storage units that are primarily semiconductor-based. Such solid-state storage units have been in use in the mainframe world for almost a decade, so don't be surprised to see them migrate to network servers, workstations, and even desktop personal computers. While they do include a magnetic disk for backup in the event of power loss, solid-state disks are permanent storage devices.

Another class of semiconductor devices that is being used for mass storage is the flash EPROM. While not as fast as DRAM, flash EPROMs hold their data when you power down (see "Store Data in a Flash" on page 311). They thus combine some of the speed of semiconductor devices with the permanence of magnetic media.

The Optical Path

The biggest challenge to magnetic mass storage comes from optical technologies such as CD-ROM, WORM (write once, read many times), and erasable optical disks. Optical storage is slower than magnetic primarily because of the greater mass of optical read/write heads, but it offers greater capacity. And because optical-media cartridges are removable, you can store far more data than the



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capacity of the disk would indicate. Disk changers even alleviate the need to manually swap cartridges.

With semiconductor memory possessing a speed advantage and optical storage having greater capacity, magnetic disk storage is being squeezed on both ends. But advances in all aspects of hard disk technology, from basic materials to disk subsystems, ensure that the newcomers will be shooting at a moving target.

Magnetic Basics

A hard disk drive stores data by magnetizing areas on the surface of the disk. "On" and "off" bits are represented by areas magnetized in opposite directions. The read/write head is an electromagnet that writes a bit by magnetizing an area with the proper orientation. The head determines whether an area represents a 0 or a 1 by the current induced in the head by the magnetized area.

Hard disk drives store bits on concentric tracks on a disk that spins at 3600 revolutions per minute. To increase the capacity of a hard disk, you have to increase the number of tracks per inch. To increase the performance of a drive, you need to increase the number of bits per track, which permits more bits to pass under the head per unit of time. Squeezing more tracks into the same area and more bits into a track requires both advanced recording media and high-performance read/write heads.

Media Messages

Until a few years ago, the recording surface of a hard disk was a plastic binder sprinkled with slivers of gamma ferric oxide (Fe_2O_3 with a particular crystalline structure). Given the monolithic ferrite heads used at the time, this material gave very good performance. The problem with ferric oxide is that it is not coercive enough to let you pack bits and tracks closely together. Coercivity is a measure of the field required to reverse the direction of magnetization of a bit on the magnetic medium. As you pack bits closer together, you need very high coercivity materials to ensure that a bit won't be demagnetized or have its magnetization reversed by neighboring bits.

Coating the gamma ferric oxide splinters with cobalt doubles their coercivity, but even this isn't good enough to ensure a recording density that can compare with optical densities. Today, most hard disks are coated with a continuous thin film that is sputtered or plated onto an aluminum disk. These films consist of pure magnetic material, resulting in a much higher coercivity and a reduction

in signal noise over ferric oxide coatings.

The most popular materials for magnetic thin films are cobalt-nickel alloys. Unlike ferric oxide, these films contain no nonmagnetic oxygen. Because the signal a bit induces in the head is proportional to the media's magnetization, pure magnetic media will produce better signal-to-noise ratios than media containing nonmagnetic material. This is important when you're packing so many bits together in a small area.

Another advantage to cobalt is that it is highly *anisotropic*: It responds much more strongly to magnetic fields oriented along a certain axis. Aligned properly, cobalt bits are thus highly susceptible to magnetization from the read/write head but relatively impervious to magnetization from nearby bits. This is one of the reasons for cobalt's high coercivity.

One problem with thin films is that they are susceptible to corrosion. Today, however, hard carbon coatings protect the recording media from contaminants and from damage from the read/write head, which touches the surface of the disk during starting and stopping.

Metallic thin films are the medium of choice for today's high-capacity disks and will remain so for the foreseeable future. In fact, it is no longer the medium that limits the capacity of magnetic storage. The limiting factor is the read/write head.

Closing the Gap

As today's thin-film media let you pack more bits per unit area, the bits themselves become smaller and, even with pure magnetic materials, produce smaller signals. To read a bit on this scale requires a head that has a very small gap between the poles of the electromagnet; otherwise, the fields from adjacent bits would interfere with the signal. It must also be sensitive enough to detect the weaker signals from the smaller bits.

Even before thin films were used on recording media, they were the materials of choice for read/write heads. Their anisotropic properties help ensure that the signal they read is from the target bit only. The ability of drive manufacturers to construct heads that fly as little as 100 nanometers above the disk is also critical, because a closer head also has a better chance to read the weaker signals from smaller, higher-density bits.

Beyond Induction

Despite the advantages of thin-film heads over the older ferrite heads, the limiting factor that keeps the bit density of magnetic disks below that of optical



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disks is the difficulty in reading closely packed magnetic bits. Heads that read by induction have a harder time reading smaller bits, because the intensity of the signals induced by such bits drops linearly with the size of the bits.

Last year, the IBM Magnetic Recording Institute (San Jose, CA) demonstrated a noninductive magnetic head capable of reading bit densities as great as 1.8 million bits per square millimeter. This is almost triple the data density of most popular magneto-optical drives.

The demonstration drive used a magneto-resistive head to read the tightly packed bits. This head uses a thin-film element containing a single magnetic domain strung between two electrical leads. The resistance of the element changes as the angle of its magnetization does. The angle, in turn, changes as the element passes over the different bits in the recording layer. Because different polarities in the bits produce different angles of magnetization, which in turn produce different resistances across the element, the head reads the data by monitoring a current passed through the element.

Although no production drive uses magneto-resistive read heads, this demonstration proves that magnetic media have a lot of life left. The density advantages of optical drives may not be as great in upcoming years.

Other technologies that may affect the density of magnetic media in the years to come include the metal-in-gap heads, first popularized in Sony 8-mm videotape decks, and perpendicular recording, which produces vertically oriented magnetic domains on the media. See the text box "Side by Side" for more on perpendicular recording.

System Advances

While advances in basic technology continue to contribute to the speed and capacity of hard disk drives, advances in other areas of hard disk systems also contribute to the vitality of the media.

Perhaps the most common way to speed up hard disk access is to couple a hard disk drive with a cache of fast semiconductor memory. Recently, controllers with caches of 1 MB, 2 MB, and even 4 MB have become common on workstations and high-end personal computers. These controllers combine many advantages of semiconductor memory with the safety and permanence of hard disk storage.

Beyond simple caching, many companies are producing hard disk systems for personal computers that rival those in

Side by Side

Bill Passavanti

Recent technology advances have brought about a new generation of higher-capacity floppy disk drives. Among these, perpendicular recording, a technology developed by Toshiba, uses a new material—barium ferrite—on the recording media. Unlike conventional oxide media in which particles are magnetized horizontally, or parallel to the recording surface of the disk, barium ferrite particles are magnetized vertically, or perpendicular to the recording surface (see figure A).

With the particles in the recording media arranged more closely together, you can store more bits in the same linear space, thus increasing data capacity. Data particles take less room when you line them up side by side instead of end to end. Bit density increases from the 17,434 bits per inch you get on a conventional 2-megabyte floppy disk to 34,768 bpi, resulting in a 4-MB storage capacity and a fast 1-megabit-per-second data transfer rate.

In addition to increasing data storage capacity, perpendicular recording also improves data integrity. Since the particles are magnetized vertically, there is a sharp magnetic transition between the particles. Even high densities maintain this transition to clearly define each data bit. This orientation minimizes peak shift and reduces coercivity (see figure B). With conventional floppy disk recording, increasing the bit density crowds the particles, thereby reducing the magnetic-transition space, blurring bit transitions, and increasing peak shift.

The barium ferrite that is used in perpendicular recording also improves data integrity. Since barium ferrite particles are flat platelets, they provide a relatively flat data surface. Consequently, a strong, continuous read signal is induced in the read/write head when you read the data (see figure C). Conversely, conventional floppy disks exhibit a read signal that fluctuates between strong and weak because of the magnetization and shape characteristics of the media particles.

To accommodate perpendicular recording, the drive is engineered using some conventional drive components combined with new and modified elements. Changes to the perpendicular-recording drive include a narrower gap on an otherwise conventional ferrite-ring read/write head; modified read/write electronics to accommodate the higher data rate; and a full-track-width erase head that provides the full, deep erasure required in a perpendicular-recording system.

While offering both performance and storage capacity improvements over conventional floppy disk technology, perpendicular recording promises to continue the tradition of cost-effective storage that has made present-day floppy disk drive technology so popular. The use of conventional and readily available drive components, combined with the ability to manufacture the barium ferrite media in high quantities with the use of existing coating facilities, has kept the cost of perpendicular recording low compared to other new floppy disk technologies.

Another element that makes perpendicular recording cost-effective is downward compatibility. Perpendicular-recording floppy disk drives will allow you to read and write data using disks formatted by conventional 1-MB and 2-MB drives. Therefore, you can upgrade your system without rendering your existing floppy disks obsolete: Your data remains accessible while you gain in performance and storage capacity.

Future changes in servo technology that will allow for more precise positioning of the read/write head will bring about capacity increases in perpendicular-recording systems of up to 32 MB in the next couple of years. Ultimately, barium ferrite technology will store as much as 64 MB of data on a single floppy disk, providing higher storage capacity along with the cost-effective, volume-manufacturing characteristics that are required of floppy disk drives.

Bill Passavanti is vice president of marketing for floppy disk drives with the Disk Products Division of Toshiba America Information Systems (Irvine, CA). He can be reached on BIX c/o "editors."

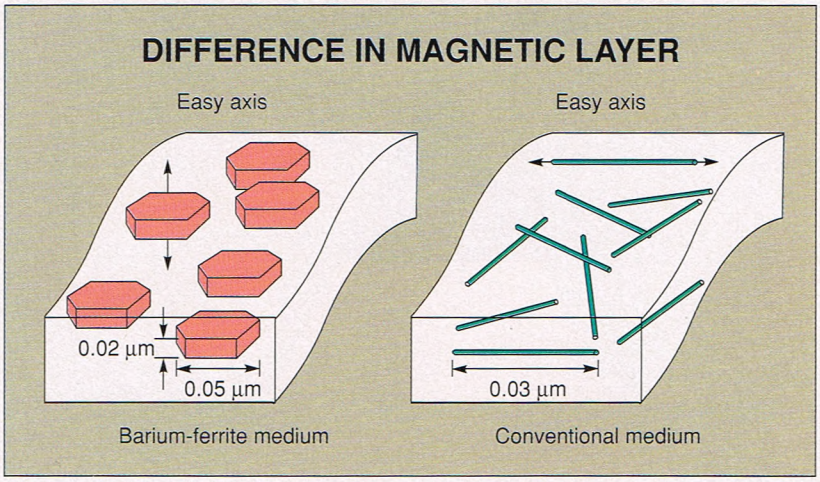


Figure A: *In the barium ferrite medium (left), particles are magnetized vertically—perpendicular to the recording surface. In the conventional oxide medium (right), particles are magnetized horizontally, which takes more room.*

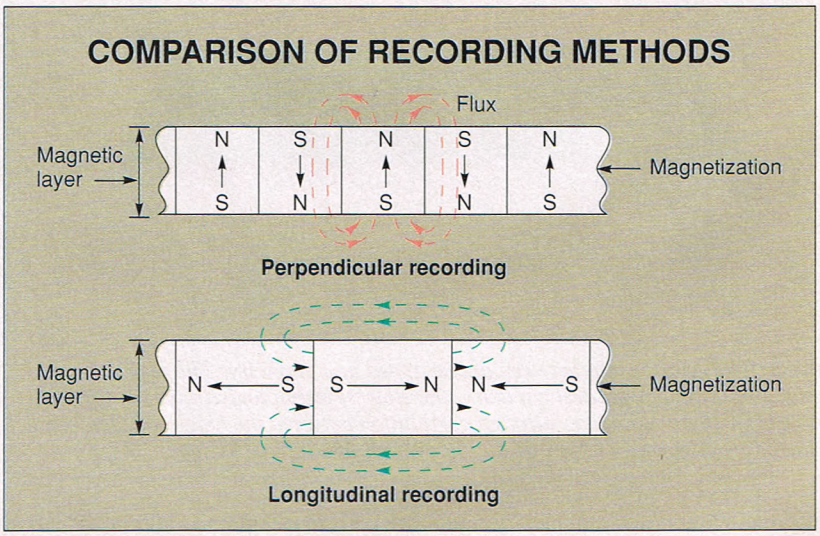


Figure B: *Since the barium ferrite particles (top) are magnetized vertically, there is a sharp magnetic transition between the particles, even at high densities. This is in contrast to the conventional oxide particles (bottom).*

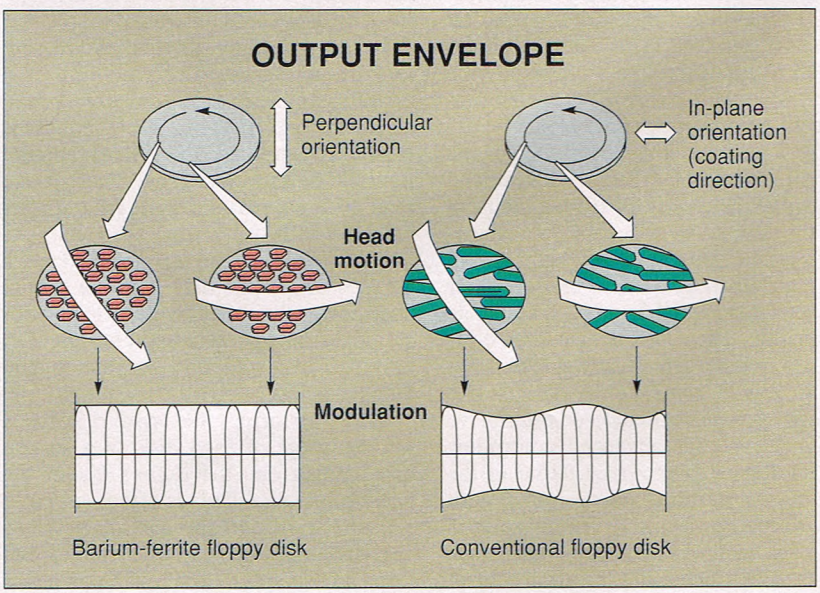


Figure C: *Barium ferrite particles are flat platelets and provide a relatively flat data surface and a strong, continuous read signal (left). However, the media particles of conventional floppy disks exhibit different magnetization and shape characteristics and a fluctuating read signal (right).*

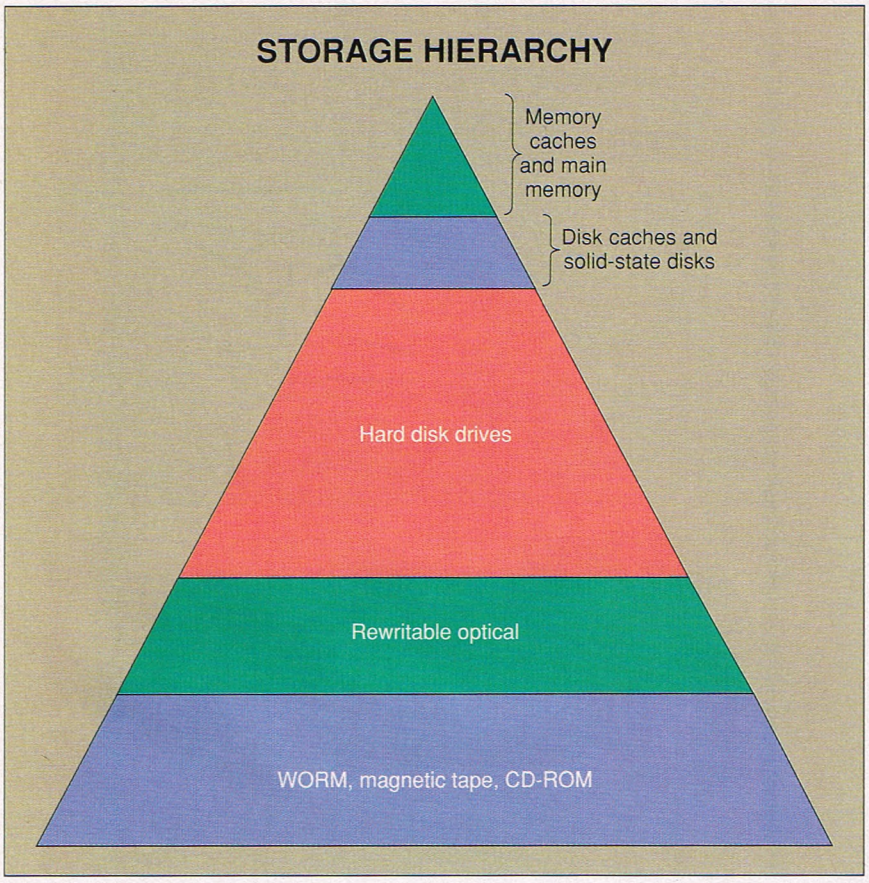


Figure 1: *The relationship between access speed and capacity: The fastest technologies have the smallest capacity; the slowest technologies have the largest capacity. The pyramid makes a rough correlation between the height of each block and the percentage of each type of storage present in a typical system.*

mainframe systems for complexity and storage. Earlier this year, Zenith introduced a new hard disk drive controller with its Z-386/33E. This controller is designed to minimize the amount of time spent waiting for a read/write head to seek the proper track and sector.

The Zenith controller can detect the current location of a read/write head and determine the distance between the head and the data it has to access. In a single-drive system, this isn't very helpful, but in a multiple-drive system, the controller can determine which head is closest to its destination. The controller can then initiate data transfer from that head first.

The Zenith controller is designed to increase the performance of multidrive systems. Another advanced controller, the Intelligent Disk Array found in the Compaq Systempro, is designed with fault tolerance in mind. The Systempro supports up to four pairs of hard disk drives. Each drive has its own control cable, and each pair shares a data cable. The controller is thus able to read data from all four disk pairs at once. The IDA maximizes the benefits of this arrangement by using sector striping.

In sector striping, sequential data sectors are not arranged contiguously on a disk. Instead, the sectors are spread across the eight disks in the system. This is a big plus because the system can read multiple disks at one time. Thus, it can read different parts of a file from different disks at the same time.

Of course, sector striping can be a curse if one of the drives on the system goes down. Suddenly, every file on your system is missing some sectors. The IDA provides two solutions: mirroring and data guarding.

With mirroring, the system keeps a mirror image of each disk on a second disk. When one drive goes down, the backup kicks in. This is effective, but it eats up half of your storage capacity.

Data guarding is more complex but takes up less space. It takes 25 percent of your disk space to store a combined image of the disks in the system. Every time you write a byte to a disk, the corresponding byte on the other disks is read. The system combines the bytes with an exclusive-OR and writes them to a special area. If a drive fails, you simply read the bytes from the other disks and perform an XOR on them to recover the missing data. The IDA can perform this data recovery in the background.

The Storage Hierarchy

Advances in recording materials, heads, and controller subsystems will ensure that magnetic-disk storage keeps up with its solid-state and optical cousins. However, these alternative technologies will find a place on an increasing number of desktops, not as replacements for magnetic disk storage, but as adjuncts.

The different types of direct-access computer storage, from main memory to WORM drives, fall into a pyramidal hierarchy (see figure 1). At the top are memory caches and main memory. As you go down the pyramid, you encounter storage technologies that offer increased capacities but slower access times.

Until recently, hard disk technology was unchallenged in the field of permanent direct-access storage. For most people, it continues to be their only form of permanent storage (other than floppy disks). However, as personal computer systems increase in size and complexity, optical and solid-state storage will see their share of the pyramid increase. Rather than being the only show in town, magnetic media will share storage duties with other technologies better suited to certain applications.

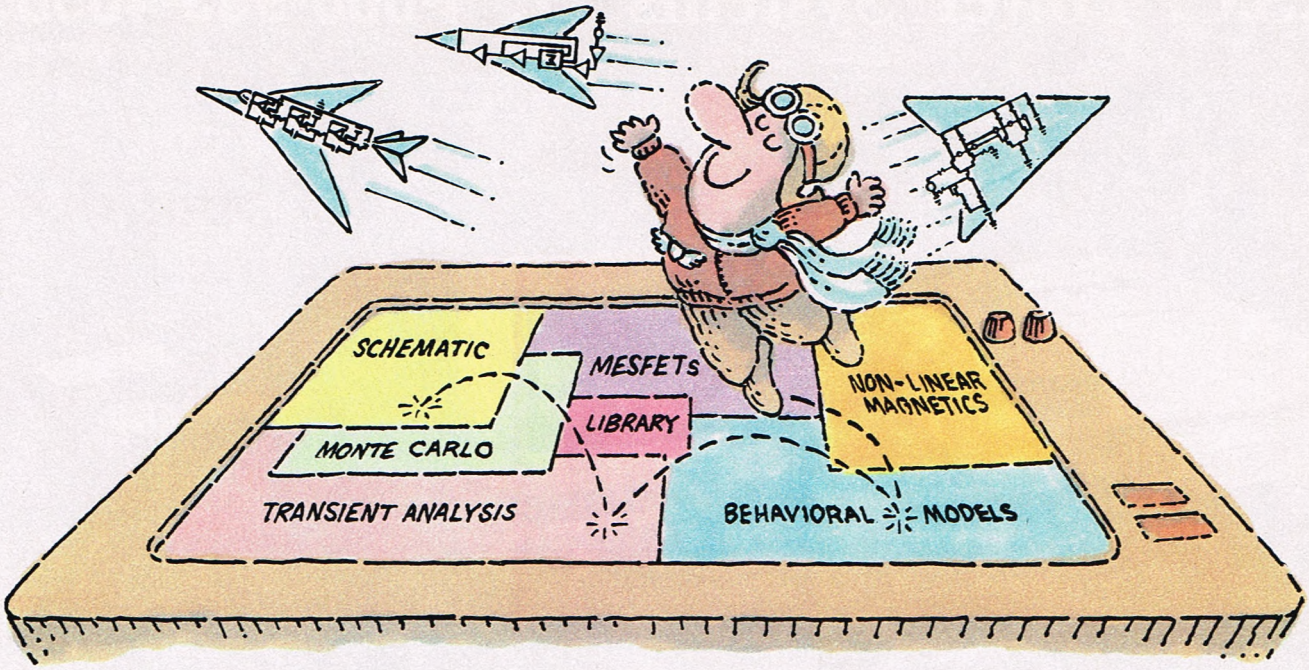
One of those applications is archival storage. Hard disk drives are simply too expensive to waste on archival storage. Why should you pay for sub-10-millisecond access to data you retrieve once a month, if that often? Archival storage demands capacity, not speed, so it is an ideal domain for erasable optical disks, WORM disks, and magnetic tape.

The Main Squeeze

The future of magnetic media is not in doubt; it will remain your most important form of permanent storage. But you will increasingly see it augmented by other forms of storage (e.g., solid-state for very fast storage, and optical for high-capacity archival storage).

Magnetic media will be squeezed on both ends by these alternate technologies, but it's doubtful that it will ever be squeezed out of the storage pyramid. ■

Bob Ryan is a BYTE technical editor. You can reach him on BIX as "b.ryan."



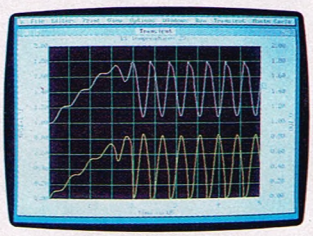
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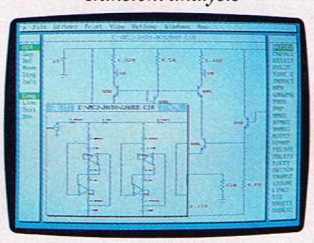
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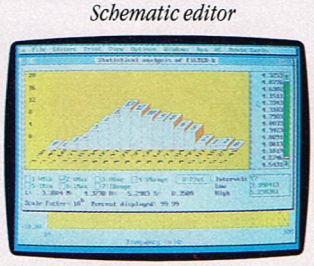
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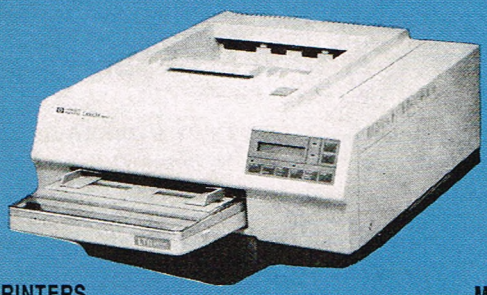
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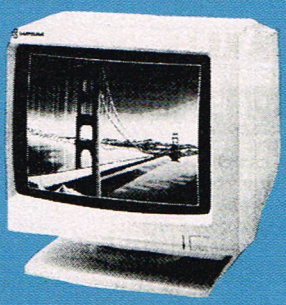
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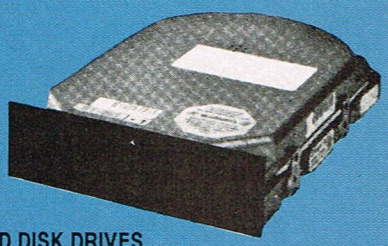
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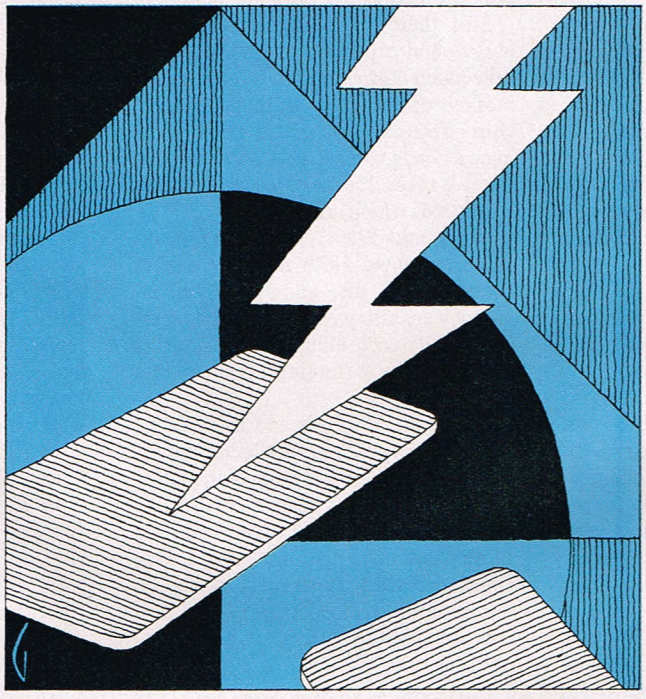
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Circle 267 on Reader Service Card

Store Data in a Flash

Flash-memory ICs offer new options for personal computer storage

Walter Lahti and Dean McCarron



Normally, you'd think of a flash flood as a natural disaster, something that could pick you up and carry you away. But the flood of flash memory that is about to reach the personal computer world will be a positive event. It will carry the power to expand the reaches of personal computing.

Flash memory is a nonvolatile memory IC. Born of the blending of EPROM and EEPROM, the flash IC is functionally and technologically the offspring of these parents (see the text box "Do You Remember?" on page 312). It is reportedly named for the speed with which it can be reprogrammed.

While flash and EPROM memory cells usually contain a single transistor, a DRAM cell typically contains a transistor and a capacitor, an EEPROM cell two transistors, and a static RAM (SRAM) cell four or six transistors. Obviously, the more cells, the more real estate (silicon) a memory requires. And real estate is always expensive.

Advantages of Flash

Flash's two significant attributes, nonvolatility and DRAM-like speed, are ideal for solid-state "disk" drives. Flash-based disks are very fast compared to most available disk drives (see figure 1). In 120 nanoseconds, you can access data stored in flash memory, while it takes 15 to 30 milliseconds to access data stored on today's typical hard disk. In some implementations, such as in portable computers, the speed advantage of flash over disk drives is even greater.

Today, a personal computer's hard disk drive is one of its most power-hungry components. When you use a desktop machine, you may not notice this power consumption. But the power a battery-operated portable can supply is limited—and hard disk drives use up that power quickly. Most portables today require fairly sophisticated power management facilities to extend the amount of time the machine can be used.

A portable's power management facility often turns off the hard disk drive if it isn't being used. While this is great for extending a portable's limited battery life, it is terrible for performance. When the power comes back on, the disk drive's motor can take several seconds to bring it up to speed before disk I/O can begin. A flash-based disk needs no warm-up. When you turn on the power, the data is immediately available. With no waiting, you experience no loss in performance.

In addition to achieving power savings from an "instant-on" flash disk, you also realize savings from not having to operate power-hungry motors and servos. A 1-megabyte flash disk requires a maximum of only 1.2 watts while operating.

ILLUSTRATION: JOE GAST © 1990

Do You Remember?

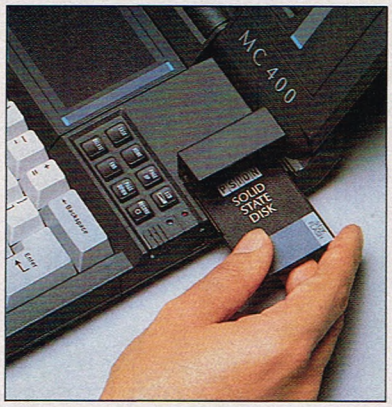
There are two kinds of memory: volatile and nonvolatile. Memory such as DRAM is called volatile if it forgets what it had stored when you turn off your computer's power. Memory such as ROM is called nonvolatile if it retains its data whether or not your computer's power is on. As all users who have ever turned off their computers before saving files to disk can tell you, the DRAM used in your personal computer to store programs and data cannot retain information without power.

DRAM, however, is reprogrammable; the information it contains can be changed. When you load a new file, the new information replaces the old. ROM, though, is not reprogrammable—the programs and data in ROM are permanent, and you can't change them.

In the early 1970s, the only semiconductor memory available was DRAM, its cousin static RAM—which is also volatile—and ROM. The choices open to computer designers were using memory that was reprogrammable but lost information without power, and using memory that always retained information but could never be changed. What designers really needed was memory that could be reprogrammed in the system and that also retained its contents when the power was off.

A few years after DRAM became available, a new kind of memory known as electrically programmable read-only memory, or EPROM, was introduced. EPROM is reprogrammable and nonvolatile. But it has one drawback. In order to reprogram EPROM chips, you have to remove them, expose them to high-intensity ultraviolet light for as long as 20 minutes, reprogram them, and then replace them in your computer. Thus, EPROM fell short of being the ideal memory. Today, because vendors find them easier to program, EPROM chips are largely used as replacements for your personal computer's ROM.

Electrically erasable programmable read-only memory, or EEPROM, was introduced in the late 1970s. EEPROM (like EPROM) is reprogrammable and nonvolatile, and it can also be easily reprogrammed within the computer.



Psion uses four Intel 1-Mb flash-memory ICs in its credit-card-size solid-state disk.

Still, there are drawbacks. EEPROM is slow and expensive and doesn't hold very much data. Today, you can store 1 megabit of data in an ordinary DRAM chip. You can access the data in 80 nanoseconds, and it costs $5. In contrast, it takes 150 ns to access a 1-Mb EEPROM, which costs $265.

In the mid-1980s, Toshiba Semiconductor invented flash memory. About the same time, Intel and Seeq Semiconductor were also working on flash memory. While each manufacturer built its flash memory differently, they operate similarly.

Like both EPROMs and EEPROMs, flash memory is nonvolatile and reprogrammable. But it has none of the faults of these other types of memory. Unlike EEPROM, it is inexpensive: Today, a 1-Mb flash memory costs about $15. Unlike EPROM, flash memory can be reprogrammed electrically while it is embedded in the system—either by you or via system software.

Still, one drawback remains. With DRAM, you can change a single bit at a time, but with flash memory, you can change only a sector (consisting of multiple bytes) at a time. While constraints of sector-level reprogrammability prevent it from replacing your computer's DRAM, flash memory is well suited to other applications.

The type of storage that hard and floppy disk drives provide resembles that of flash memory. Disks are nonvolatile—they hold onto data with or without power. And disks are reprogrammable—you can change the files whenever you want to. The similarities between flash memory and disk storage led to the building of "disks" based on the concept of flash memory.

A flash disk isn't a disk drive at all; there are no disks or moving parts. A flash disk is a set of flash-memory parts mounted in a credit-card-size package that acts as a hard disk. This same set of parts could be mounted on a board inside a machine. The difference between the two is that one is removable storage and one is fixed storage. A flash disk emulates a disk drive.

A flash disk is built from one or more flash-memory ICs and some controlling logic devices. For example, to build a 512K-byte flash disk, you could connect four 1-Mb flash-memory ICs and place them on a small card. Psion has used this principle with its flash disk (see the photo).

Flash disks operate fairly simply. At the hardware level, the computer simply sends digital read or write signals to the disk with the address of the information. If it is a read signal, the disk responds with the requested information. If it is a write signal, the disk takes information from the computer and stores it.

In addition to flash-disk hardware, you also need software to manage the files on a flash disk. This file-system software handles creating and deleting files, changing the file sizes, and formatting the flash disk. Microsoft has worked with Intel to create the Microsoft flash file system, a standard MS-DOS-compatible flash-disk interface that makes it much easier for vendors to use flash disks in their computers.

The lowest-power hard disk drives today require about 3 W.

The fact that flash-based disks have no moving parts carries with it yet another advantage—reliability. While hard disk drives have become remarkably tough, on occasion they still do crash.

Flash-based storage is very reliable because a flash disk is as tough as the rest of the electronic hardware in a personal computer. It takes a lot for a flash disk to fail: The flash memory must be damaged physically, through destruction of the device package, or electrically, by an extreme electric shock or a power spike.

Disadvantages of Flash

Flash memory's extremely high speed, low power, and high reliability would seem to make it the ideal storage technology. Unfortunately, there are two significant drawbacks to flash disks. The most severe limitation is its cost. A conventional 40-MB hard disk drive costs about $320, or $8 per megabyte. Today, a 1-megabit flash IC costs $15. Eight flash ICs are needed per megabyte of flash disk, making a flash disk cost about $120 per megabyte.

Thus, you would have to pay about $4800 for a 40-MB flash disk, or about 15 times what an ordinary hard disk drive would cost. Because of this present inequality, the first mass-produced flash-based disks probably will store less than 40 MB. In the future, flash-based disk prices will certainly decline, making large amounts of flash-disk storage more affordable. In a few years, you should only have to pay about $600 for a 40-MB flash disk.

The other problem with flash disks is that they can't compare with hard disks in density. The highest-density flash memory available today stores 2 Mb per IC—you would need 160 of these ICs to produce a 40-MB disk. Like all memories, flash memory is expected to grow in density, so eventually far fewer ICs will be needed.

Two Flavors

Manufacturers currently offer flash devices in two programming flavors: those that require a 5-volt power supply, and those that require a 12-V supply. With both erasure and programmability possible at 5 V, only one power supply is required at the system level. The benefits of this feature are reduced system-component cost and space savings. Thus, flash is ideal for portable-computing applications.

The 5-V flash cell is generally a modified two-transistor (or split-gate) derivative of EEPROM and is packaged with a different pin-out than the 12-V varieties. Five-volt programming lets a system interface with the device in much the same way it would with SRAM. Therefore, for some applications, a flash device can replace SRAM, particularly in systems that use SRAM with battery backup.

While both 12-V and 5-V flash memory can be used as an SRAM replacement, the 5-V feature becomes more desirable for portable equipment where no external 12-V power is available and the addition of a 12-V power supply is not feasible.

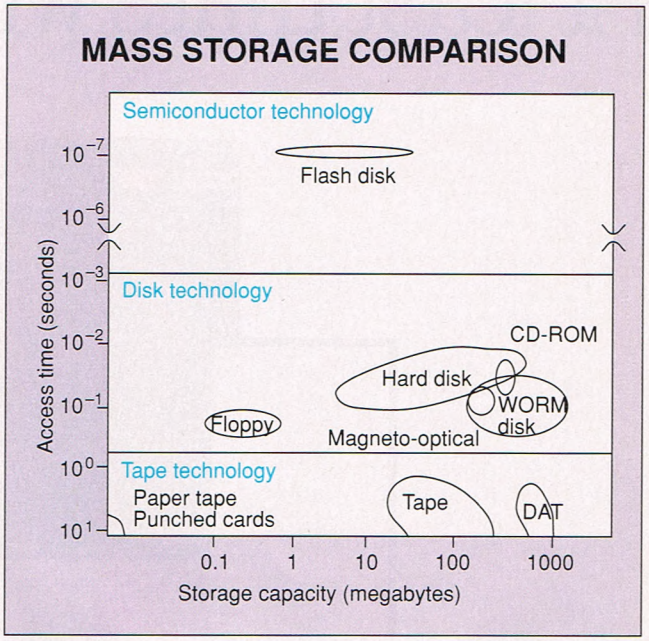


Figure 1: *Flash disks are 125,000 to 250,000 times faster than today's hard disk drives. However, they are limited to up to 40 MB in capacity, whereas hard disk drives can store from 5 MB to 1 gigabyte.*

Ideal for Laptops and Palmtops

Laptop and notebook computers are the ideal applications for flash disks. With current hard disk drives, you must carry around heavy batteries, deal with short amounts of work time, or suffer from hard disk drives operating at floppy disk drive speeds. Flash disks will answer all

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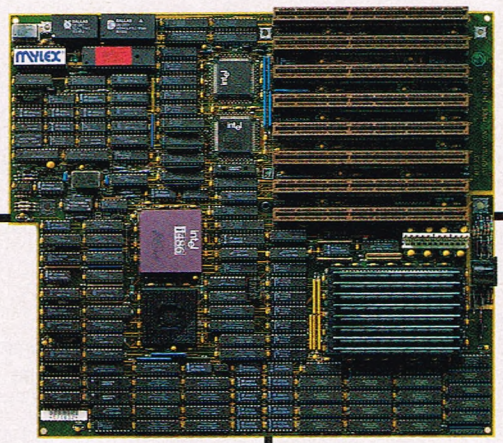
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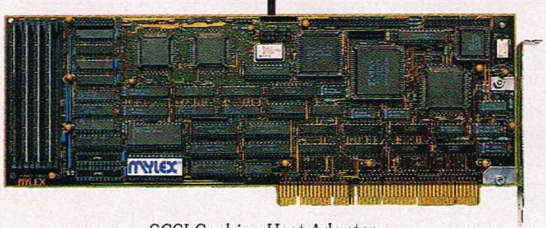
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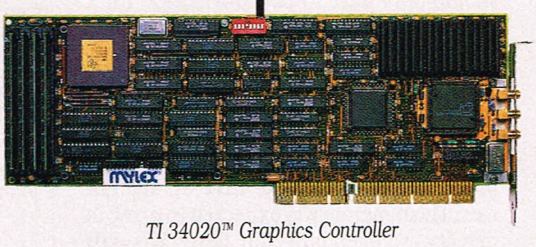
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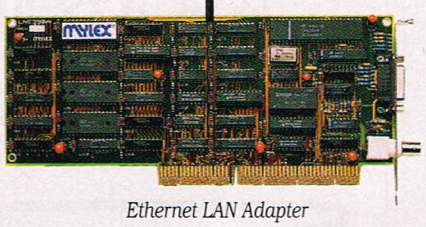
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You can also benefit from flash memory in other implementations. Flash will let you update your laptop's ROM with the latest versions of DOS, or any other operating system, whenever you want to. Laptops save space on disks and in RAM by placing the operating system in ROM. The problem with this is that you can't update the operating system without replacing the entire ROM—an expensive proposition. Thus, laptops often use old but reliable versions of DOS. Using an old version of DOS may mean that your computer won't need a ROM replacement in the near future, but it may not run recently written programs, either.

One thing lacking in palmtop computers, such as the Poqet PC and Atari Portfolio, is small, convenient mass storage. Without any optional peripherals, their storage is limited to programs on ROM cards and memory-expansion cards that lose their contents when they are removed. With flash-based memory cards, you can put your own programs and data onto the card, modify them at will, and not worry about losing the information when you remove the card. These features make flash-memory cards the logical choice for the palmtop's missing "floppy disk drive."

Laser Printers

If you use a laser printer, you can benefit significantly by using flash memory instead of ROM. In laser printers, ROM stores programs and fonts. ROM replacements are expensive because printer-control language programs have become large and are subject to frequent upgrades and improvements. Using a laser printer equipped with flash memory instead of ROM to store control-language programs, you can reprogram your printer's control language yourself at no cost and without replacing any ROM.

Currently, laser-printer font-storage options leave much to be desired. You have three choices. You can download a font to the printer each time it is needed, wasting your time and the laser printer's memory. You can place a font in a ROM cartridge and plug it into the printer, but you are limited to a selection of only a few fonts out of the hundreds available. Or you can store a font on a dedicated hard disk connected to the printer.

But when you use flash memory inside your printer, you only have to download a font once and it remains in your printer until you choose to delete it from the printer's memory. Because you decide which fonts are stored in the printer's memory, you can really personalize them according to your preferences. You no longer have to buy cartridges that come with a half-dozen fonts just to get the one font you need.

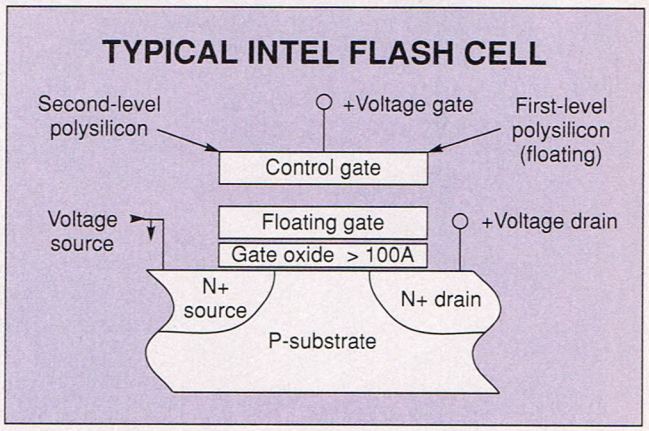


Figure 2: *A flash-memory cell is basically one memory bit (on or off). An array of up to 4 million flash-memory cells can be connected to form a flash IC.*

Fabrication Techniques

Flash devices are manufactured using designs and processes similar to those used for EPROM and EEPROM, so the technology is evolutionary rather than revolutionary. Because manufacturers have dealt with similar products, they will be able to climb the learning curve much more rapidly than if the technology were completely new. Thus, vendors planning to produce flash memory should be able to attain manufacturing costs close to, but perhaps not equal to, those enjoyed by EPROM.

However, flash devices are a bit more complex and more silicon-hungry than

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EPROM devices. The most common flash chip is an array of single-transistor memory cells and looks much like an EPROM (see figure 2). It is slightly larger than an EPROM of equal density to allow for the command port and peripheral circuitry that supports the in-system rewrite function and provides an on-chip processor interface.

The typical EEPROM chip is made of an array of two-transistor cells to enable bit-level erase/reprogram. For any given density, it requires much more silicon than either the EPROM or flash cell. Because a major cost determinant in any IC is the silicon required, the EEPROM is a more expensive part.

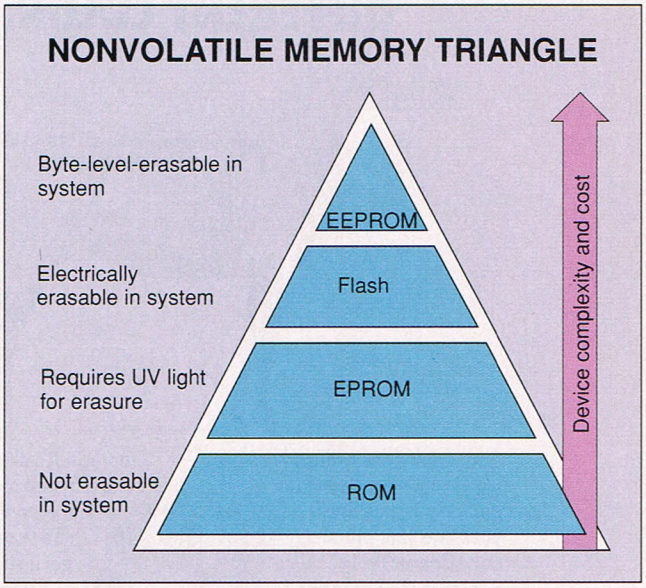


Figure 3: *Technology trade-offs for semiconductor nonvolatile memories. As programming flexibility increases, so do device complexity and cost.*

Erasing and Reprogramming

In terms of reprogrammability, the flash IC falls somewhere between the traditional EPROM and EEPROM (see figure 3). A major difference between flash memory and EPROM is that flash does not require ultraviolet light for erasure, as does the traditional EPROM. While flash resides in your system, you can electrically erase it in much the same way as you would an EEPROM.

The energy needed to discharge or erase the gate in a typical EPROM is derived from UV light, a requirement that makes it difficult and time-consuming to erase an EPROM. In a typical flash IC or EEPROM, energy resident in the system can be used to erase a group of memory cells or the entire chip. This feature makes it easy and fast to erase a flash IC in the system.

You generally cannot erase a flash IC on a byte-level basis as you can with the EEPROM, but some flash ICs can be erased on a sector-level basis. Flash ICs are usually reprogrammable by hot electron injection, a solid-state physics process that uses the energy in the system. It is possible to program on a byte level, but because it is not possible to erase on a byte basis, reprogramming is limited to sector or the entire chip.

Because the flash device does not require UV light for erasure, the chip does not need to be housed in an expensive ceramic window package such as that required for an EPROM. Therefore, flash is also an excellent candidate for surface-mount technology.

The advantage of surface mount is that there is less distance between the device and the board. This reduction can lead to improved reliability, better system performance, and higher board density, as well as reduced cost. Also, the flash device can readily be packaged in memory-card configuration and handled as if it were a floppy disk, which is important to the portable computer world.

The total cost of using flash memory can be considerably lower than that for EEPROM and, with some applications, close to that for EPROM—about $6.50 for a 1-Mb EPROM versus over $250 for a similar-size EEPROM. On a comparable device-density basis, flash memory's $15 average selling price is much lower than the EEPROM's and greater than the EPROM's. With flash, application solu-

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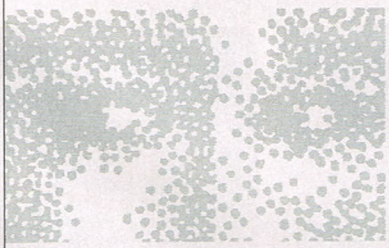


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The law of the semiconductor jungle is that over time, all device types see improved performance and reach greater density levels. At the same time that silicon real estate is minimized, costs are significantly reduced. By 1994, the cost of a megabyte of flash memory is expected to move from its current level of about $120 to about $15.

Flash in the Pan?

Unless developers are able to overcome the current limitations of flash disks, you will probably continue to use hard disk drives on your desktop computer for mass storage. Hard disk drives are inexpensive and fairly reliable, and they can store plenty of data. Although single-user personal computers will probably continue to include hard disk drives, eventually network servers will probably offer both hard disk drives and flash disks on-board.

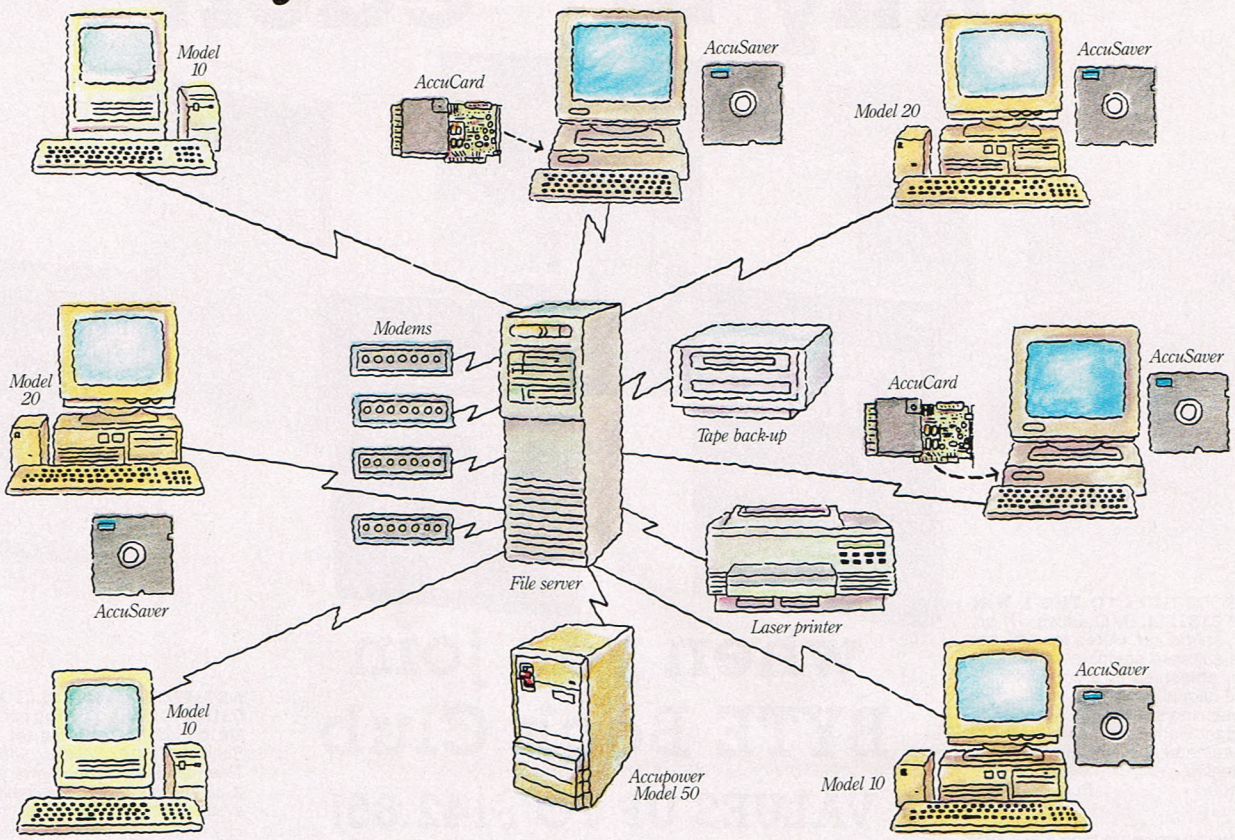
On many servers, you frequently access files, such as programs, that are rarely changed. Flash disks are ideally suited to perform this service. You can store seldom-changed program files on flash disks, relieving the burden on the server. By doing so, the server's response to program load requests will be far faster than if the files were stored on a hard disk.

Flash memory combines the advantages of an EPROM's low cost with an EEPROM's ease of reprogramming. These advantages will allow flash memory to make significant contributions to personal computers. Portable computers will be the first to benefit from this new technology, as flash-based disks increase their speed, operating time, and ruggedness. ■

Walter Lahti and Dean McCarron are vice presidents of In-Stat (Scottsdale, AZ), a company that provides market research for the electronics industry. They can be reached on BIX c/o "editors."

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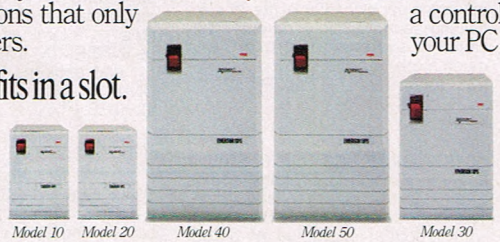
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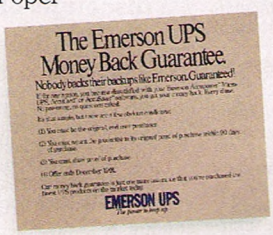
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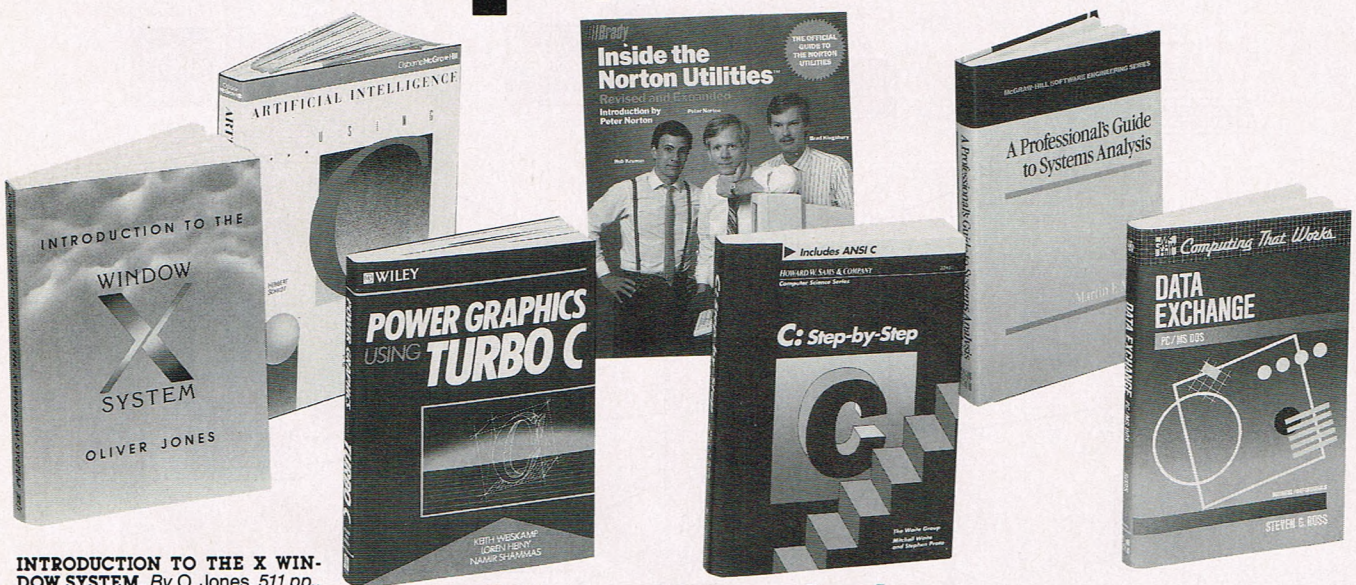
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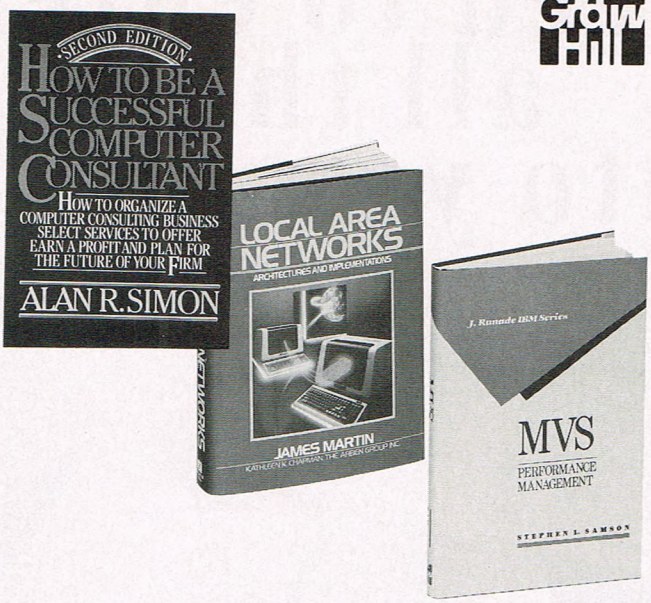
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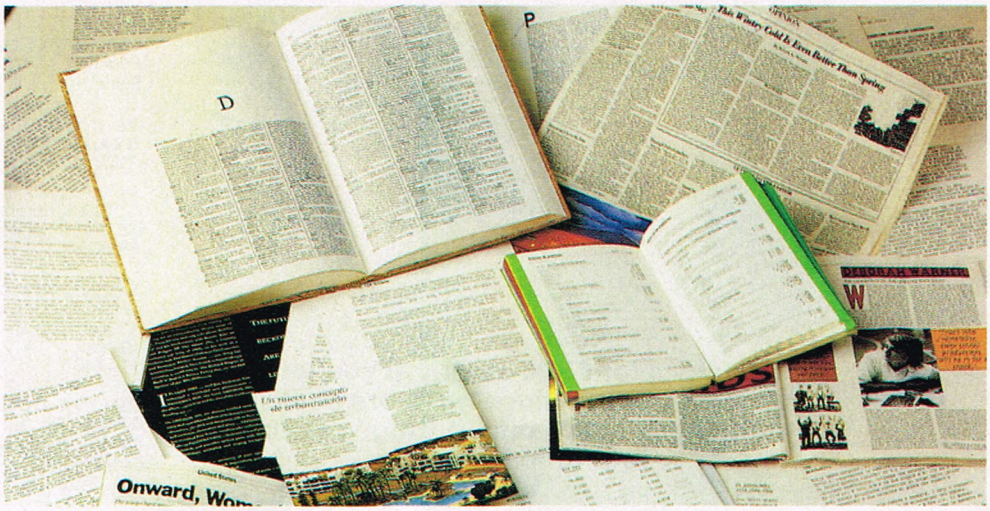
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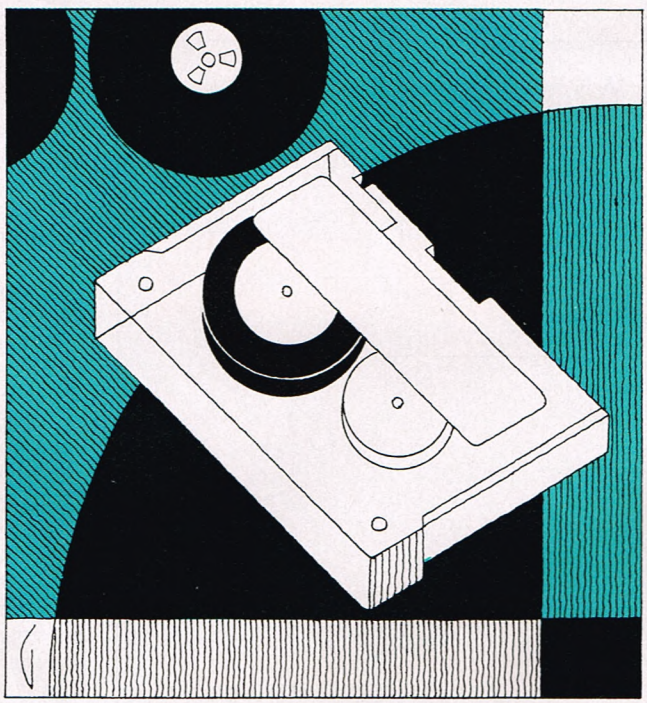
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DAT's a Solution

Reliable multigigabyte backup storage with digital audiotape

Karina Lion



Tape backup has been around for a long time. In the early days of computing, mainframe shops developed half-inch reel-to-reel tape drives. (Such drives remain popular in centralized computing environments today.)

Then, with the advent of personal computers, came quarter-inch tape drives. Quarter-inch cartridge tape, developed originally to store 5 megabytes of data, soon became a popular backup solution for the stand-alone PC.

Next came the 8-mm tape format. This storage medium, developed in the 1950s for the video industry, uses the standard VHS recording method, *helical scan*. The primary benefit to early users of 8-mm tape was its ability to store over 2 gigabytes of data on a VHS cassette. Like its quarter-inch and half-inch cousins, 8-mm tape employs analog recording methods.

To date, just one company manufactures 8-mm tape drives: Exabyte Corp. Nonetheless, 8-mm tape backup products have proliferated into many operating environments. Prior to the advent of 4-mm digital audiotape (DAT) in the microcomputer arena, the Exabyte 8-mm tape was the only high-capacity tape-backup solution available.

Now comes DAT data storage, which uses digital recording technology developed for DAT devices in the music industry. In 1988, GigaTrend introduced the first DAT drive for computer data. Numerous companies have since announced DAT products, including JVC, Hitachi, WangDAT, Archive, Wangtek, Hewlett-Packard, Mitsumi, Sony, and Teac.

No mystery surrounds the popularity of DAT. The demand for multigigabyte storage is rapidly becoming commonplace. The backup and archival requirements of PC LAN users, for example, have grown exponentially in the last five years. Users of high-end workstations and minicomputers also need multigigabyte backup solutions.

DAT shares with 8-mm tape the ability to store gigabytes of data on a small tape cartridge. But although the two technologies are able to store comparable quantities of data, DAT drives are cheaper to manufacture. What about optical storage? CD-ROM/WORM (write once, read many times) technology provides quick random access to files. But optical disks cost more than 4-mm and 8-mm tapes, and they hold less (only 600 to 700 MB), so you pay for the privilege of instant access to files. If that's what your application requires, go with a CD-ROM or WORM drive.

DAT systems, like conventional and 8-mm tape drives, can of course locate individual files, but there's a delay. For most backup applications, however, tape

ILLUSTRATION: JOE GAST © 1990

remains the medium of choice. And, per megabyte, DAT is cheaper than 8-mm tape storage.

Making the Connection

DAT drives, like the conventional tape drives and hard disk drives, come in two flavors: internal and external. The internal DAT systems are available in full-height and half-height models. On a LAN, you can attach a DAT system to a file server or to a network node.

DAT systems support various interfaces. SCSI has become the de facto standard for DAT drives. Older tape drive interfaces such as QIC-02, used with quarter-inch and half-inch tape systems, cannot achieve the high throughput levels of SCSI. If your system already has a QIC-02 interface, your existing tape-backup software could be able to communicate with a DAT drive. You can even buy a DAT drive with a Pertec interface to modernize a nine-track tape system.

DAT VS. QUARTER-INCH TAPE SYSTEMS

A DAT system stores more, faster, for fewer dollars per megabyte.

	Quarter-inch	DAT
Capacity in production	60-500 MB	2.5 gigabytes
Next capacity level	1 gigabyte	5 gigabytes
Recording density	12,500 bits/inch	61,000 bits/inch
Maximum data transfer rate	90K bytes/sec.	207K bytes/sec.
Head technology	Stationary	Rotating drum
Recording method	Serpentine	Helical scan
Tape movement (wear/tear)	90 inches/sec.	0.32 inches/sec.
Data storage method	Analog	Digital
Media cost/100 MB (avg.)	$25	$1.20

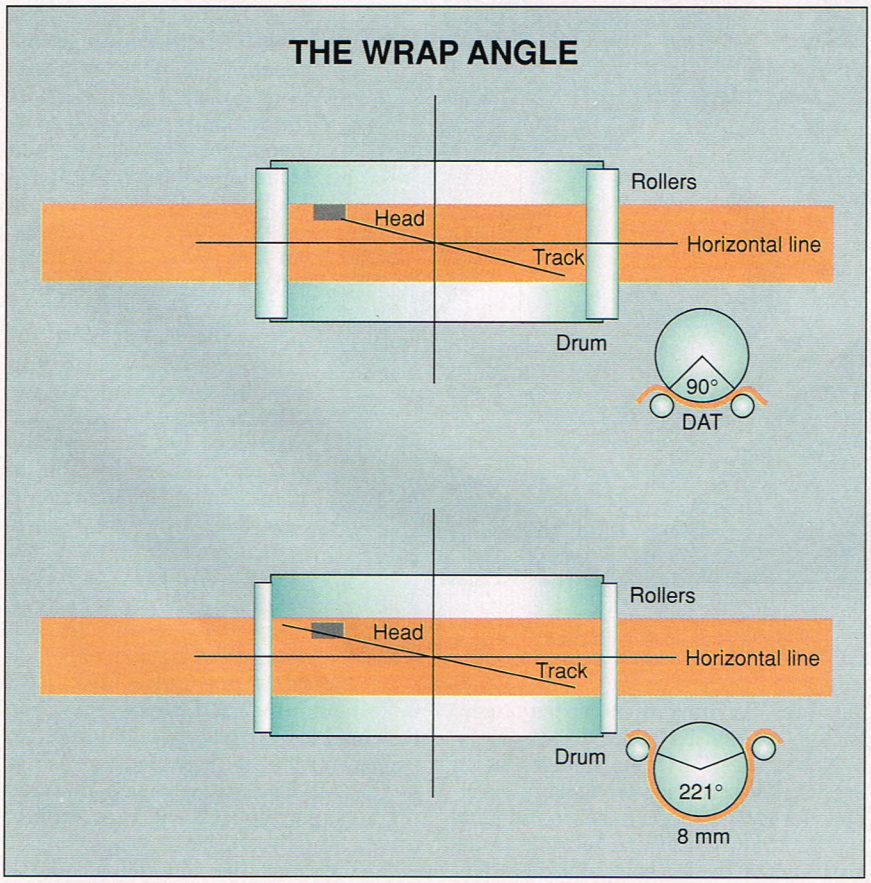


Figure 1: *A DAT system's smaller wrap angle reduces friction during normal operation and prevents stretching of the tape during high-speed searches.*

Advantages of Helical Scan

The stationary-head technology used in quarter-inch tape drives puts a great deal of stress on a tape. In order to achieve a backup rate of 5 MB per minute, a half-inch or quarter-inch tape has to move at speeds of 90 to 120 inches per second past the stationary head. (See the table for a more complete comparison of quarter-inch and DAT technologies.) That causes significant wear and tear on the tape.

As a result, 150-MB tape cartridges are rated for only about 200 passes; 60-MB cartridges are rated for 400 passes. The newer 300- to 500-MB quarter-inch systems yield only about 100 passes per cartridge. By contrast, a 4-mm DAT can sustain over 1000 passes. Why? With a DAT system's helical-scan technique, tracks are laid down in an angular format, 6 degrees from the physical edge of tape. In a single pass, a DAT system can record a gigabyte of data. Quarter-inch tape technology requires 24 passes to record 150 MB.

In addition to wear and tear, the speed at which tape moves in conventional quarter-inch systems creates other problems. As the tape passes rapidly over the stationary heads, friction causes heat, which can distort the tape's metal-oxide coating. Such distortion can compromise the integrity of data. That's why every quarter-inch tape drive incorporates a tape-tensioning mechanism that the drive must monitor continuously to ensure accurate performance.

DAT systems employ a rotating drum. Because the heads on the rotating drum do most of the work, the tape doesn't need to travel so fast. DAT moves at a mere one-third of an inch per second. The tape heads record the data in a herring-bone pattern. Unlike with the linear recording method of quarter-inch tape, with a DAT drive each head can read only its own track. Tracks can overlap, which prevents gaps on the tape and cuts down on wear and tear. All this enables the tape to travel more slowly, and therefore to last longer.

Both 8-mm systems and 4-mm DAT systems employ helical-scan technology. One key difference is the degree to which the tape wraps around the rotating drum. In the Exabyte 8-mm system, the angle of wrap is 221 degrees; with a 4-mm DAT system, it's only 90 degrees (see figure 1). The smaller 90-degree wrap angle reduces friction and requires fewer moving parts.

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The DAT system's narrower wrap angle confers another advantage over 4-mm tape systems: It prevents stretching of the tape during high-speed tape motion. That means file access can occur at 200 times the nominal read/write speed.

To obtain high-speed reads of the tape's file marks, DAT manufacturers now use a digital strobe at the beginning and end of each track. The technique is called *logical file marking*. This differs from the 8-mm system's file-marking method—an erased length of tape followed by a series of tracks. These *physical file marks* use up a lot of tape. In some cases, file marks can consume as much as 2 MB, so a 2.3-gigabyte 8-mm tape can end up with only about 1.8 gigabytes of data.

The 8-mm systems and 4-mm DAT systems also use different head arrangements (see figure 2): 8-mm drives have separate servo (positioning), read, and write heads. With 4-mm DAT drives, the servo heads are integral with the read and write heads. The latter scheme, which does not depend on mechanical alignment of servo and data heads, can better follow distorted tracks.

DAT Standards

Two DAT recording methods now await ANSI approval. DDS (digital data storage) is a streaming method similar in operation to half-inch and quarter-inch tape drives that support the QIC command set. The other method is called DATA/DAT. Its features include fast sequential storage and high-speed file search with indexing. DATA/DAT also has a random-write mode that supports multiple (up to 254) partitions on a tape.

DDS does random reads, but not random writes. It's a bit faster than DATA/DAT, but it isn't designed for updating files in place. DATA/DAT, which supports block- or sector-oriented operations, does support partial updates.

Forward Error Correction

Recording vast amounts of data on a tape of such large capacity requires superior error-detection methods. With a 1.2-gigabyte tape, the conventional error detection of one error in 10^8, the usual with traditional drives, is unacceptable. Using read-after-write in conjunction with cyclic redundancy checks does not prevent the types of errors that only show up

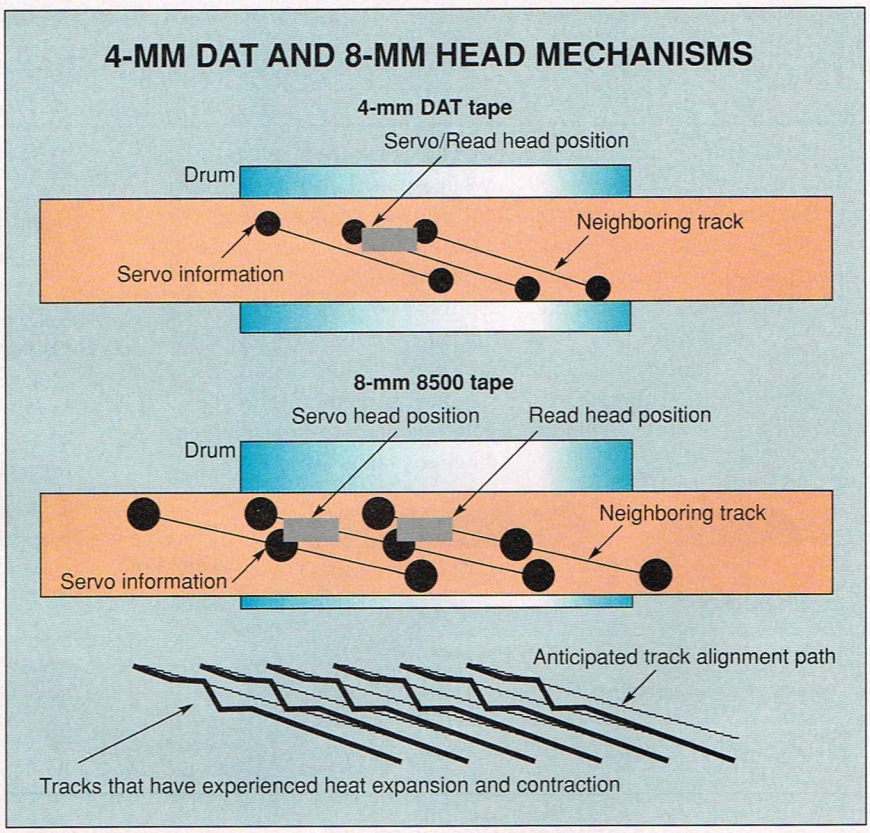


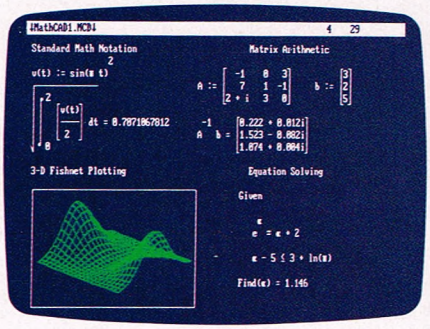
Figure 2: *An 8-mm tape drive's separate servo and data heads can have trouble following distorted tracks. The 4-mm DAT drive's integrated servo and data heads track more faithfully.*

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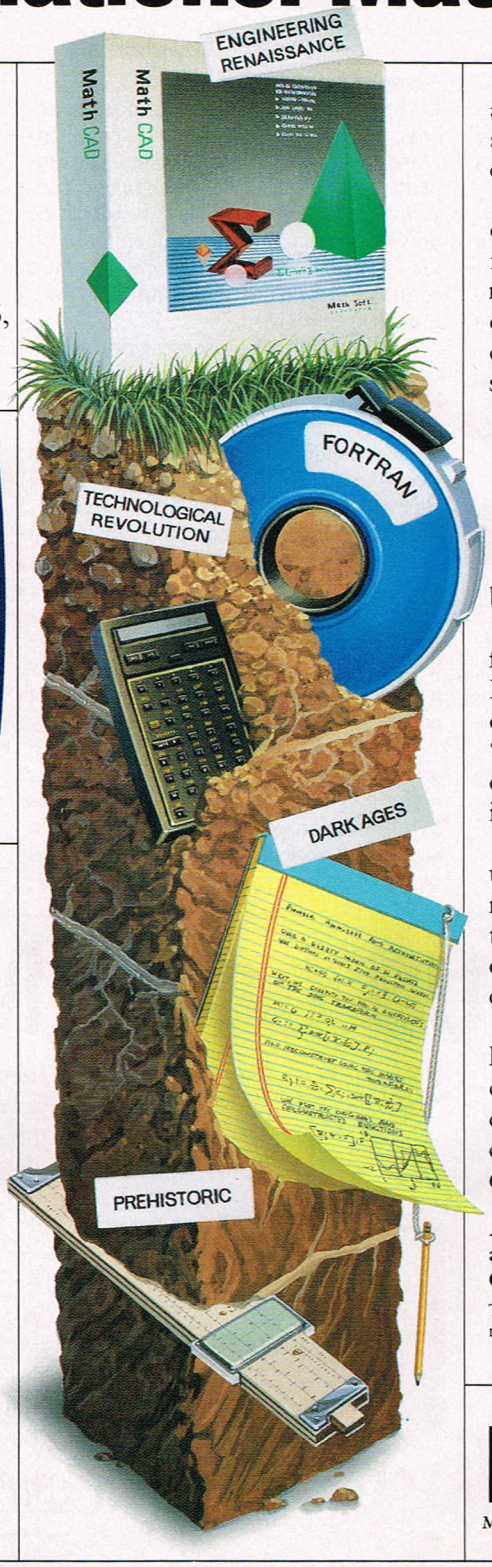


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when a tape is being read later, such as those produced by capstan flutter. Forward error correction (FEC), used only in DAT drives, reduces the error rate to one in 10^{15} bits. To put it another way, there is only one error per 1,000,000 tapes.

The drive's electronics implement error correction using information from two correction layers on the tape. FEC can correct up to 640 consecutive bytes in a 4K-byte block. Older tape-recording methods, such as quarter-inch, cannot ensure this level of accuracy.

Both DDS and DATA/DAT use a technique that segments the data-recording track into two areas of the tape. Approximately 60 percent of each track is allocated to user data and error-correction coding. The remainder stores the automatic track-finding information used to keep the tape head centered on the track, along with saveset marks and file marks.

Interleaving

Both DAT formats support interleaving, which prevents the stop/start phenomenon that occurs when a tape drive must stop its streaming operation because it must wait for the host to catch up. A DAT system supports interleaving by buffering data and by writing only complete groups of data while the tape is in continuous motion. This provides an economical way to use an entire tape from beginning to end without wasting start/stop time. Sophisticated DAT drives now contain "adaptive interleaving" that shortens the tape-repositioning time even more.

Although DDS and DATA/DAT have been introduced as separate standards, they will probably continue to coexist. Backup applications that don't require a quick file-restore feature can use the slightly faster DDS format. Applications requiring quick access to file marks and fast restore will use DATA/DAT.

Modes of Access

DAT systems support three modes of access: streaming, random, and update-in-place. With streaming access, you append data onto a tape. To change a file, you write a complete new version; all previous versions of the file remain on the tape. The partition, or tape, does not require preformatting, and no spare groups are provided.

With random file access, you can locate any file on a 1- or 2-gigabyte tape in less than 60 seconds. A DAT system, uniquely, does this in a way that emulates a standard block device, such as a floppy or hard disk drive. A tape, or a subportion of a tape called a partition, must be preformatted. The formatted tape (or partition), now called a data group, can be overwritten, or refreshed, without the need to change other sections of the tape. Note that 4-mm DAT storage devices can do random reads (as opposed to random writes) in all three modes of access.

The update-in-place mode is the most advanced form of the random-access technology. In this mode, data access is a combination of both the random- and sequential-access methods. Append and overwrite capabilities are both provided, but no preformatting is required. Instead, formatting is done "on the fly" by allocating spare groups at set intervals. This method of dynamically formatting and altering files increases data transfer rates with random writes, while simultaneously maintaining areas of the tape with streaming compactness, where needed.

DAT's Bright Future

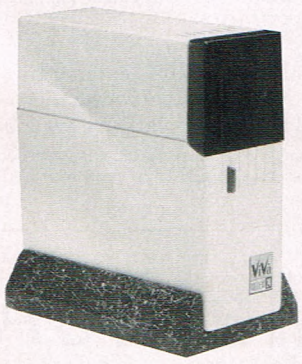
With primary disk storage growing at a precipitous rate, DAT technology offers a fast, reliable way to keep those big disks safely backed up. It can be useful in other ways, too. With a DAT system's random-access and update-in-place capability, you might want to keep primary storage uncongested by off-loading certain files (e.g., images) to tape. That scenario would require more sophisticated application software than is available for DAT systems today, but it's entirely feasible.

A DAT system offers a higher level of reliability and data integrity than its analog predecessors. Already more than 15,000 DAT drives are installed in Europe and the U.S. The technology requires little training. If you're responsible for large quantities of data, you'll probably soon be saving that data on a DAT. ■

Karina Lion is executive director of public relations and corporate communications for GigaTrend. She holds a B.B.A. degree from George Washington University. She can be reached on BIX c/o "editors."

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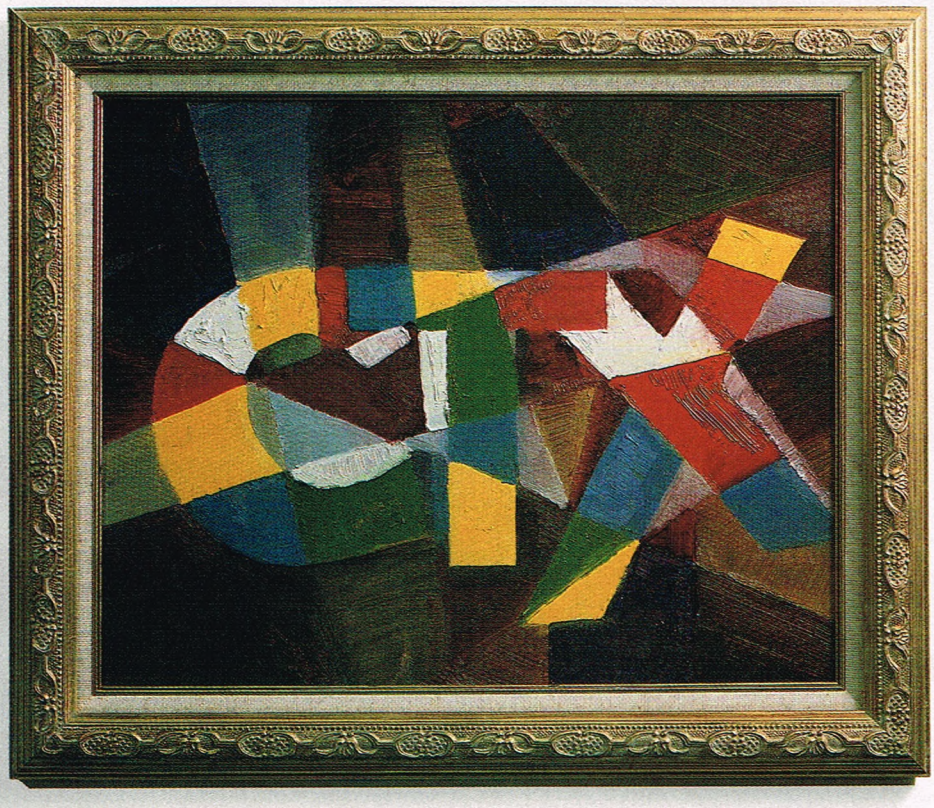
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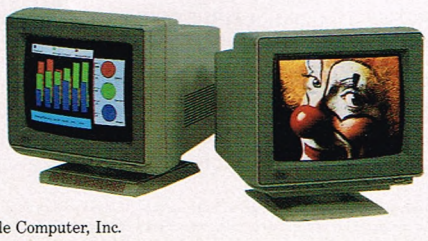
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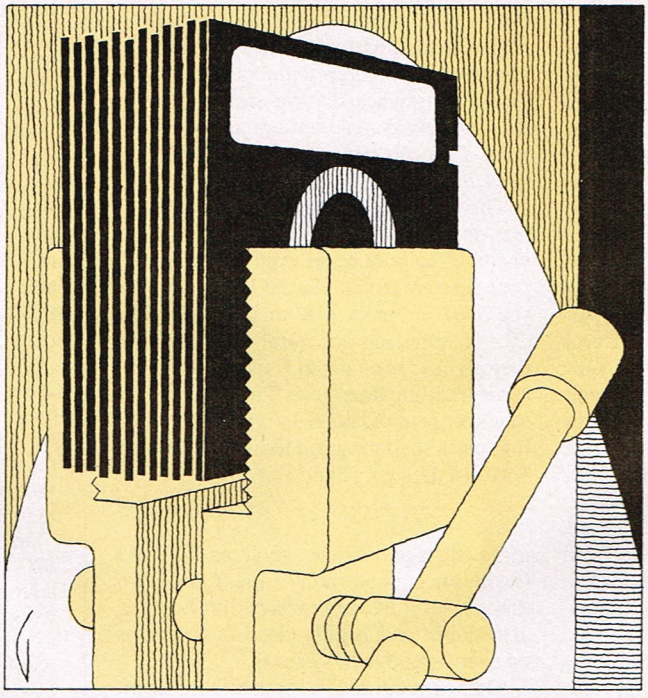
Hardware-based data compression is transparent and automatically compresses everything you store

Steven J. Vaughan-Nichols

Sixty megabytes of files on a 40-MB disk! And 120 MB of data packed onto an 80-MB tape, with faster access time to boot. You can squeeze more data onto a disk or tape than you might think.

More than ever, mass storage devices are bursting at the seams. Hard disk drives routinely come in sizes of over 100 MB, and some tapes can hold over a gigabyte of information. Even so, the number and size of files continue to outstrip storage capacities.

Data compression is one solution. You may think of that as a software solution (see the text box "Software Solutions" on page 332), involving the selective compression of individual data files. However, hardware solutions also exist. Hardware data compression is transparent and automatically compresses everything you store. Often, these techniques are embedded in hard disk and tape drive controllers.



A Gigabyte for QIC

The most notable successes for hardware data compression have come in the realm of quarter-inch tape drives. For several years, the popular quarter-inch cartridge (QIC) format could hold no more than 320 MB of storage. Recent advances in data-compression and tape-length technology, however, have made it possible for these cartridges to hold over a gigabyte of information.

With this boost in capacity, QIC technology is emerging as a serious choice for *any* backup job. Within the next year, gigabyte-plus QIC drives will begin appearing. Then, QIC can be considered not just for single-user systems, but also for LAN backups and even mainframe and minicomputer backups.

In the forefront of this technology is Stac Electronics. Its product, the StacPack 9703 data-compression chip, has become a market leader in this developing field. Indeed, the QIC Standards Committee has declared Stac's hardware-compression algorithm a standard: QIC-122.

But there are standards, and then there are standards. Many tape backup firms have hesitated to use the Stac chip. They are, understandably, concerned about backing the wrong horse in what is turning into a four-way race of competing data-compression chips.

Advanced Hardware Architectures, InfoChip Systems, and Hewlett-Packard have also thrown their hats into the ring. Unfortunately, their chips are completely incompatible with each other. Isn't that just what you need—another compatibility question to worry about? However, it hasn't stopped some companies from leaping into the fray.

Colorado Memory Systems, a leading supplier of QIC tape drives, adopted Stac's data-compression algorithm

ILLUSTRATION: JOE GAST © 1990

Software Solutions

There's more than one way to compress data. Currently, the most popular method is to use a shareware or public domain file-compression program. You have several choices if you decide to go this route (see "Saving Space" in the March BYTE).

Now, as then, PKzip from PKware is your best choice. The program, now up to version 1.10, continues to stand out in both speed and efficiency. In addition, you can now view zipped files and manipulate them with popular commercial programs, such as Lotus's Magellan.

The popular LHarc 1.13 excels at data compression, but you can feel yourself growing gray as you wait for it to complete a job. There have been rumors that a turbocharged LHarc is in the offing, but so far I haven't seen any sign of it. The other popular programs, PAK, ARC, and Zoo, remain unchanged.

Software Pluses . . .

There are several advantages to using file-compression software. Foremost among them is that you have much more control over which files will be compressed. If you only want to slim down data files, like databases and spreadsheets, you can arrange to do that. You can leave executable files untouched.

Another point in favor of this software is that you can use most compression formats on a range of operating systems. Zoo 2.01, its source code freely available, has been ported to every modern operating system. Unofficial, but effective, compression programs allow you to use LHarc's LZH, PKzip's Zip, and SEA's ARC files on Unix, VAX/VMS, AmigaDOS, and Macintosh systems.

Hiding behind this advantage is another one. Data that has been squeezed down by a chip must be expanded by the same kind of chip. This can make transferring information from one system to another impossible. That may be exactly what you want for security reasons. On the other hand, it could be a major obstacle if your office uses several different tape-backup systems. Software data compression avoids all this.

There is one other factor that you should not overlook: money. None of these programs costs more than $100, and Zoo is free. If you're willing to take the time to manage your burgeoning file collection, you can't beat the price.

. . . and Minuses

That's the good news. The bad news is that, compared to hardware compression, these programs are as slow as mud. They all normally use a disk as a scratchpad for their temporary files. This performance shackle ensures that they will always lag behind pure hardware data-compression implementations.

There's more. Compression routines that do their work in hardware are invisible. You may never even know that your files are being reduced in size. But you'd never make that mistake using data-compression software. One thing they all have in common is their painful command-line interfaces. The only way to make them palatable to many people is to use a shell program like California Software Design's Shez 5.6.

before it had even made the move from software to silicon. In 1989, the company adopted Stac's algorithm in its software for the Jumbo tape line.

This option enables you to increase the backup capacity of the QICs by approximately 50 percent. This increase, in turn, drops media costs to well under 50 cents a megabyte for the frequently used DC-2000 40-MB QIC drive. In addition, increased production has continued to force the price of QIC drives down.

Even with the additional price of the Turbo-Compression data-compression board, these reductions push system prices per megabyte to well under $10. Coupled with the increased capacity of mass storage devices such as WORM (write once, read many times) and hard disk drives, QIC drives have thus become affordable and highly desirable options on even single-user systems.

Data throughput, always a sore point when making backups, has also improved. The 9703 chip can, in theory, slim down input data at a rate of 750K bytes per second. More impressively, the chip can expand data to full size at up to 5 MB per second.

In practice, mechanical and data-path size considerations drop the overall system performance considerably. Even so, there's an impressive increase in speed when you use a QIC-40-compatible tape

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AUTOMATING ON A SHOESTRING



By Julie R. Caruso

Automating an office on a budget is a common challenge businesses face. The project can be particularly difficult when the company doesn't have the money to replace a diverse base of equipment and software that has been purchased randomly throughout its history, and needs to incorporate these resources into an integrated, smoothly functioning network.

A case in point is the automation of the Fulton County Planning and Economic Development Department in Atlanta, GA. Faced with a limited budget, an odd assortment of computer brands and models, a need to connect four individual departments with 30 users located in two buildings, and a growth plan that demanded a doubling of the initial network solution within a one year period, the County set to work finding the best solution.

"Our major concern was to be able to link all the existing, yet different, types of personal computers, future add-on personal computers, and dumb terminals into a cost-effective system," said Dr. June Woodward, who, as Director of the Georgia Systems Development and Technical Systems Department, oversaw the project.

Woodward turned to National A. I. Lab, Inc., an Atlanta-based national distributor of network solutions, for help. After carefully assessing the County's needs, Jim Williamson, president of National A. I. Lab, recommended a "hybrid" system that combined both shared and distributed processing using PC-MOS and LANLink 5X, both products from The Software Link.

"By combining both types of technology using products that are compatible with the broad base of hardware and software that the county already had in place, we gave them a solution that didn't cost a lot of money and allows the expansion they require," said Williamson.

In fact, the system cost more than $200,000 less than other alternatives the county considered. In three years the network has grown from supporting 30 users to serving more than 104 users through a combination of PC-MOS, LANLink and Novell's NetWare.

"In addition to saving us money, our network has dramatically increased our productivity," said Dr. Woodward. Our word processing capacity has increased by more than 200 percent, and we're doing much more of our work by computer because the network is accessible to everyone who needs it."

Julie Caruso is Managing Director and Director of Sales and Marketing for The Software Link, Inc.

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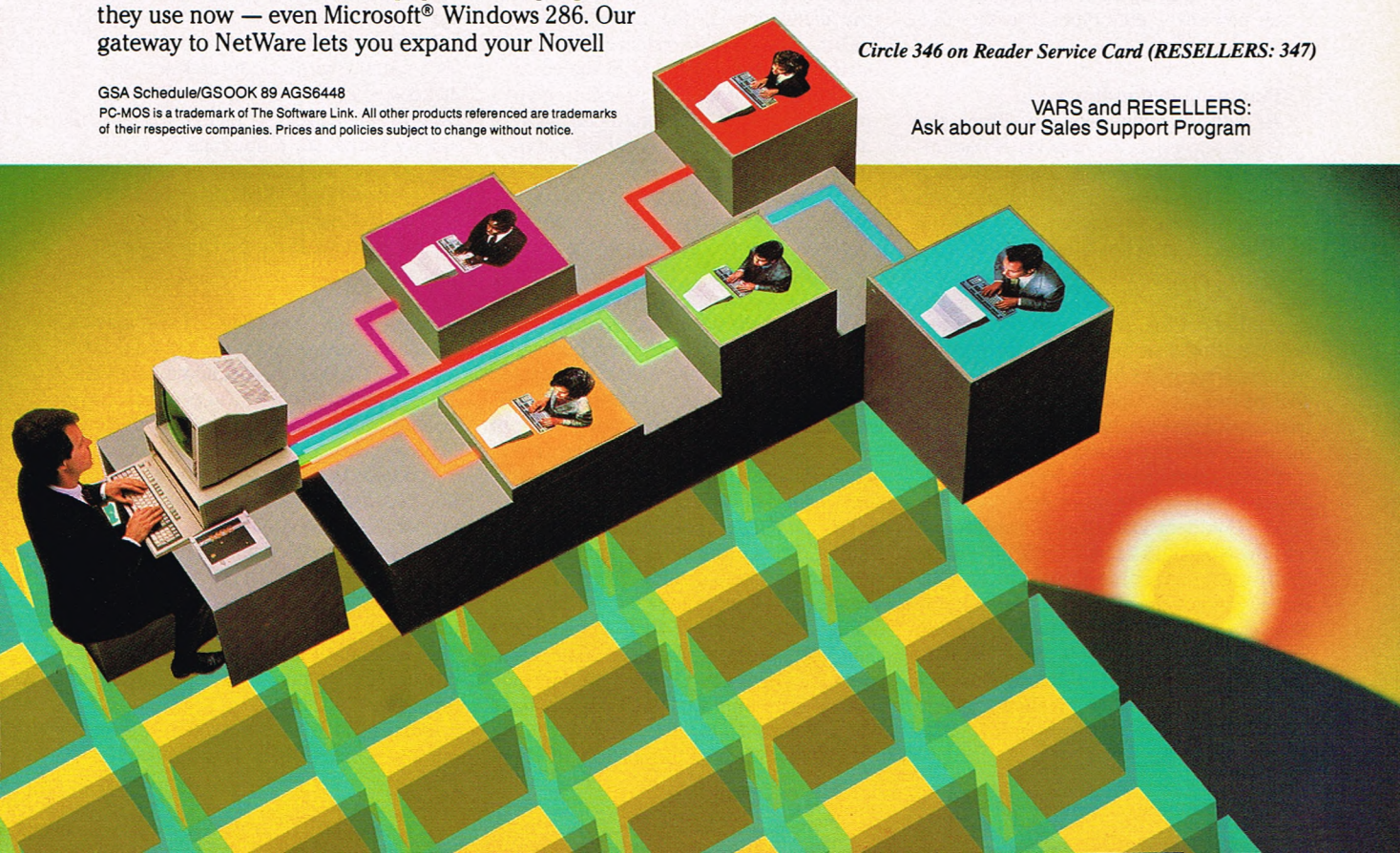
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A One-Sweep Approach

A typical example of the marriage of data compression and primary storage technology can be seen in Hewlett-Packard's half-inch reel-to-reel streaming 7980XC tape drive. When using the 6250 GCR tape format, this drive uses a real-time data-compression engine and a "superblocking" packing process to achieve data-compression ratios that average better than 2 to 1.

The 7980XC accomplishes this by allying two different components. The first is the integrated circuitry that contains the data-compression engine. This subsystem catches data as it goes back and forth from the disk interface and the tape-cache buffers. Having captured the data, it then compresses and decompresses it on the fly.

The algorithm that actually does the work appears to be based on a public-domain version of the Lempel-Ziv algorithm. That isn't surprising. Most data-compression schemes owe a debt to this algorithm and its close relative, Lempel-Ziv-Welch. Hewlett-Packard's enhancement to the basic theory was to modify the contents of the data dictionary. This makes an algorithm that gives good compression results, no matter how many data types it tackles in a single session.

Removing Redundancy

As with all compression algorithms, the key to success is the removal of data redundancy. That's more easily said than done. The Hewlett-Packard program encodes patterns that are found in the input stream. When a unique data string comes along, it's placed in a dictionary. The string can be any kind of data, from ASCII to imaging data.

The dictionary contains records with two elements. The first field contains a unique string, and the second holds a code word that represents the string. This dictionary is made up of 4096 record positions and must be initialized before data compression begins.

The first eight locations in the dictionary are reserved for control flags. The next 256 positions are assigned a value range from 0 to 255. These represent the familiar ASCII characters. The remaining 3832 entries are set aside to hold unique strings. As the program fills these entries, it link-lists the other entries in the dictionary to them. The records always end with a pointer to the records that contain the ASCII values.

The program searches the dictionary for matching strings as data is input. If it can't find a match, it enters the data string into the dictionary and assigns it a code word. These code words are output to the mass storage device, where they make up the building blocks of the compressed file. They are 9 to 12 bits long, depending on the record's position in the dictionary. If the record already exists, the program replaces the data string with the code word of the corresponding record. The program gives unique strings 12-bit-long code words after it fills all 4096 slots of the dictionary.

At the beginning of the compression cycle, the program doesn't compress data. In fact, the data stream actually increases in size at first, because the first few 8-bit words are replaced by 9-bit codes. As the dictionary fills with multicharacter sequences, the 9- to 12-bit-long code words begin to represent character strings that are at least 16 bits long. An example should make this process clearer.

The word *cat* is input as part of a data stream. The program searches for the first byte, *c*, in the dictionary. It's found in the ASCII character set. Since a match has occurred, the next byte, *a*, is added to the string. Then the program searches for the string *ca*. If it doesn't find *ca*, it makes a new entry in the dictionary for the unique string. The program sends out the code word for the longest string that was matched before the new dictionary entry was made. In this case, the 9-bit code word for *c* is output.

Then, the program drops the first byte from the search string, and the hunt begins for the character *a*. It's also found among the ASCII characters. The program adds the next input byte and looks for the string *at*. If it finds *at* in the dictionary, it adds the next byte, and then the entire search procedure begins again.

In the event that the new search string isn't found, the program makes a new dictionary entry and exports the code word for the longest string that was previously found, *at*, to the tape drive. In this case, a 9-bit code word now resides in the place of the 16-bit string *at*. Data compression has begun.

The program doesn't attempt to scan

in a Jumbo Plus system. Backup times are cut almost in half as the throughput increases from 2.3 MB per minute to 4.5 MB per minute. Colorado Memory Systems claims even better gains when using the drive with higher-capacity tapes.

These performance improvements haven't been lost on other vendors in the field. Tandberg Data A/S is planning to add the Stac chip to its line of tape drive controllers. Archive, the largest QIC drive vendor, has also jumped on the Stac bandwagon. Its product, expected by the end of this year, is named the Viper 2650. This drive will use QIC-525 tapes to store up to a gigabyte of data with an effective throughput of 500K bytes per second.

DAT: Gigabytes for Gigabucks

It's clear that by 1991 every important QIC drive will sport data-compression technology. That doesn't mean that QIC will rule the personal computer backup world, though. Digital-audiotape (DAT) drives that use hardware data compression to good effect are also on their way.

The first DAT competitor to see the light of day will be a 2.5-gigabyte 4-mm DAT drive, the TurboDAT, from GigaTrend. Stac's ubiquitous 9703 chip powers this SCSI device as well, but it's more than just another platform. The engineers of GigaTape GmbH, the German parent company of GigaTrend, have added several features to the drive.

One of the most important of these features is the use of logical file marks, which lets you store more data on a DAT than older file-storage schemes allowed. This and other enhancements have brought random-file-access speeds down to 60 seconds or less.

Archive has joined forces with Hewlett-Packard to work on producing a compression-capable DAT drive. This device is still in the development stage. It will be based on a variation of HP's DCLZ algorithm. HP already successfully uses this algorithm in its half-inch reel-to-reel 7980XC tape drive compression coprocessor. (See the text box "A One-Sweep Approach" above.)

Peripheral Vision, a data-storage newcomer, is introducing the 4Sight series of

the data before building the dictionary to determine which strings occur more frequently than others. The statistics of data redundancy indicate that you can achieve good compression performance even with a 4K-byte dictionary. A larger dictionary or a sophisticated data-analysis scan could increase data-compression efficiency, but it would slow down the operation. This one-sweep approach is at the heart of today's speedy hardware data compression.

Clearly, what would prove a good compression dictionary for one kind of file would not serve as well for another. To ensure maximum performance, the engineers at Hewlett-Packard have programmed the chip to reset the dictionary frequently.

This approach has two points in its favor. The most important is that it forces the dictionary to adapt to changes in the current data stream. The second is that the code-word length for the most recent repeating patterns will be set to 9 bits.

In other words, the algorithm is always trying to get the highest possible theoretical compression without wasting the time involved in analyzing the data and then operating on it. But the method isn't perfect. By resetting the dictionary every time *x* number of kilobytes have been processed, performance suffers when the nature of the data stream doesn't change.

Three Systems on a Chip

Originally, Hewlett-Packard coded the algorithm and proved it successful in Pascal. From there, it was ported to a proprietary integrated chip. The company then made several changes to ensure that the implemented algorithm could deal with the high-speed throughput required of a tape drive controller.

In the hardware version of the program, the dictionary is created in a 23-bit-wide static RAM bank. While it might seem that the dictionary could get by on only 4K bytes of RAM, it really needs more. This extra space handles data collisions that occur while building the dictionary. Still, the Hewlett-Packard algorithm requires far less space than many other schemes.

A single VLSI chip contains all the necessary programs and work space. This chip does both the compression and decompression processes, but it can only do one at a time. Hewlett-Packard heightened the chip's efficiency by dividing it into three semi-autonomous systems: the input/output converter, the compression and decompression converter, and the microprocessor interface. Each section operates independently of the others for the most part. Thus, the chip can maintain a high performance level even with changes in the throughput speed.

Compression and decompression are closely bonded in this algorithm. Unlike such algorithms as Huffman coding, the data dictionary is an integral part of the compressed data. As such, the program must re-create it every time it needs to decompress a data set.

While this process yields additional space savings, it also means that decompression can start at only a few specific points in the data. It would be almost impossible, for instance, to translate a fragment of a compressed file into its original form. In practical terms, this means that data can be decompressed only when it is presented in proper order to the decompression hardware.

4-mm DAT drives. These drives are supposed to raise the capacity of a 1.3-gigabyte cartridge by almost 300 percent, to 5 gigabytes. The company says that data throughput also increases by almost the same measure, from about 180K bytes per second to 700K bytes per second.

The 4Sight 4-mm drive is not directly connected to the computer. Instead, the compression device serves as a bridge between the tape system and the host. The compression system, which has its own housing, is connected to the drive and the computer by a SCSI. From the viewpoint of the host, the 4Sight DAT drive is just another SCSI tape drive. Several VLSI chips, controlled by an integral microprocessor, manipulate the data once it arrives at the device.

The actual data compression (or decompression) occurs in a 128K-byte static RAM buffer. The data is then passed on, via a second SCSI, to the drive itself. If you wish, you can switch data compression off so that other devices can read its tapes. I expect this to become a standard option on all these systems. Versatility demands it. If this option isn't available, you may want to think twice before buying such a device.

DAT drives have several obstacles to overcome, however, before they appear on every desktop. The chief obstacle is a lack of consensus on DAT formats. GigaTrend and several other major companies support the Data/DAT format. Others, including Hewlett-Packard, back the DDS (digital data storage) format.

While Data/DAT is technically superior—it enables both random reads and writes while DDS permits only random reads—that doesn't mean it will be the winner. If you consider the number of Beta VCRs sold last year versus the number of VHS VCRs, it's obvious that technical superiority is not the only criterion.

And DAT drives are far more expensive than QIC devices. In fact, the pocketbook blues may slow down DAT market penetration more than anything else and thus put the brakes on any DAT standardization efforts.

Spare Room on Your Hard Disk

Data compression on backup devices is all well and good, but what you really want is something that will give you more room on your hard disk. Several products have tried to meet this demand, and, sad to say, without exception, they've all crashed and burned.

Contrary to popular opinion, data-compression and error-correction issues were not the culprits. The devices that have come and gone have floundered on the rocks of system integration. Every operating system has its own way of addressing random-access devices. Fitting compression and decompression routines between such structures as the DOS file allocation tables (FATs) and the system BIOS is a difficult task. For instance, a file compressor could allow a logical drive to contain more than the 32 MB of files MS-DOS 3.x can recognize. New hardware systems may finally manage to fly past these hurdles.

InfoChip Systems' Disk Expander is a half-length card that offers transparent compression and decompression under DOS 3.x. While its proven IC-105 compression coprocessor can work with any mass storage device, the Disk Expander board has been optimized for disk drives.

Part of this optimization involves the use of what InfoChip calls "lossless" or "noiseless" data compression. This recording methodology uses proprietary algorithms to ensure that no errors creep in during the compression (or decompression) cycle. That may sound like wishful thinking, but it's not.

InfoChip's error-free processing is based solidly on the pioneering work of information theorist and computer scientist Claude Shannon. Information loss, often feared in data compression, is actually extremely rare due to successful implementations of the Reed-Solomon error-correction algorithm. InfoChip has taken a different road from that of

other companies, one that should lead to even more reliable data compression.

A software driver bridges the gap between the operating system and the hardware interface. It maps compressed files to the DOS FAT and intercepts all operating-system and applications calls to the drive. This software bridge is necessary because the minimal storage unit under InfoChip is the cluster.

True random block read and write operations will go much more easily than when you try to work with a file-based system. This means that an unaugmented DOS will be unable to use a disk partition under the Disk Expander. However, this may not be a major objection.

InfoChip's president, Dr. Kai P. Yiu, has stated that his company's aim is to produce a bootable drive that any normal DOS application can run on. If you don't want to put all your eggs in one basket, Disk Expander lets you have both compressed and uncompressed partitions.

You will need a separate driver for every operating system you use (and their major variants). First to be released will be the MS-DOS 3.x driver. The beta version takes up about 27K bytes of conventional memory. It will work with most conventional interfaces—ST506, ESDI, and SCSI—with one exception: It won't work on Micro Channel PCs. Other drivers for DOS 4.x and Micro Channel systems are under development.

Stac Electronics is also working on a card to bring in-line data compression to hard disks. This product is intended to compete directly with the InfoChip board. Stac is taking its time with this project, and no release date has been set.

Stac also plans to use the device driver approach, but the company has bigger things in mind than drivers. Stac's method includes a restructuring of the MS-DOS FAT and other low-level data organization structures. The driver will not cover the ground between the FAT and the compressed files, but rather the territory between the file organization and the operating system and applications.

It's a tall order, but Stac seems up to the challenge. To quote Gary Clow, president of the company, "We're being very cautious and spending a lot of time and effort in the quality-assurance area and compatibly testing before even announcing the product." Stac plans for its driver to be compatible with DOS 3.x and 4.x and the Windows 3.0 environment.

Cutting Its Teeth

The promise of data-compression firmware and hardware is bright. Graphical user interfaces demand data-storage and transmission rates that challenge even the biggest and fastest products of conventional data storage. Multimedia has data requirements that dwarf anything ever attempted on a microcomputer.

The first generation of transparent data-compression devices has arrived in the nick of time. It may have teething problems, but there will be integral data-compression chips, on either a board or a drive, working in microcomputers within the next year. High-end-computer users won't be able to live without them. LAN managers and Unix administrators in the microcomputer world would kill for data-compression benefits now. Hardware data compression can't come a moment too soon. ■

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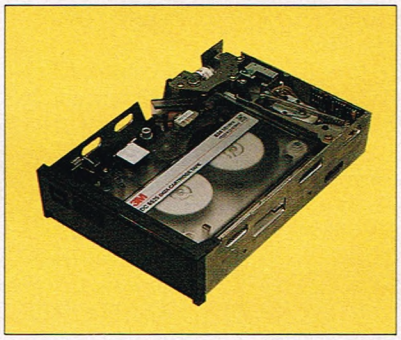


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Masses of Storage

For more information on the products and companies mentioned in this State of the Art section, contact the companies and organizations listed below.

Archive Corp.
1650 Sunflower Ave.
Costa Mesa, CA 92626
(714) 641-1230
Inquiry 1226.

California Software Design
P.O. Box 15248
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(no phone listed)
Inquiry 1227.

Canon U.S.A., Inc.
One Canon Plaza
Lake Success, NY 11042
(516) 488-6700
Inquiry 1228.

Carlisle Memory Products Group, Inc.
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North Richland Hills, TX 76180
(800) 334-8273
(817) 281-9450
Inquiry 1229.

Cipher Data Products, Inc.
10101 Old Grove Rd.
San Diego, CA 92131
(800) 424-7437
(619) 578-9100
Inquiry 1230.

Colorado Memory Systems, Inc.
800 South Taft Ave.
Loveland, CO 80537
(800) 432-5858
(303) 669-8000
Inquiry 1231.

Compaq Computer Corp.
P.O. Box 692000
Houston, TX 77269
(800) 231-0900
Inquiry 1232.

Energy Conversion Devices, Inc.
1675 West Maple Rd.
Troy, MI 48084
(313) 280-1900
Inquiry 1233.

Exabyte Corp.
1685 38th St.
Boulder, CO 80301
(303) 442-4333
Inquiry 1234.

Fujitsu America, Inc.
3055 Orchard Ave.
San Jose, CA 95134
(408) 432-1300
Inquiry 1235.

Gigatek, Inc.
1989 Palomar Oaks Way, Suite A
La Costa, CA 92009
(619) 438-9010
Inquiry 1236.

GigaTrend, Inc.
2234 Rutherford Rd.
Carlsbad, CA 92008
(619) 931-9122
Inquiry 1237.

Hewlett-Packard Co.
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Inquiry 1238.

Hitachi America, Ltd.
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(914) 332-5800
Inquiry 1239.

IBM
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(914) 765-1900
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CHIPS FOR THE NINETIES AND BEYOND

Chips that speak, reason, and identify smells offer more than just MIPS

Janet J. Barron

Chips aren't just plain chips anymore. And they aren't just faster, smaller, and smarter than they used to be. Nowadays researchers and developers are creating microprocessors that will do things that were only theoretically possible a few years ago—like speak, identify smells, train themselves, and form conclusions with less than hard-and-fast facts.

Here's a look at some of the more interesting new chips. For the purpose of this article, I'll discuss only stand-alone microprocessors (versus chip sets or modules). All are programmable, meaning that they can be "taught" to perform a number of tasks within the particular class of applications they address.

Many of these microprocessors don't fall into the category of "conventional" chips, and some purists won't consider them true microprocessors. But I have included them because they are noteworthy or have unique features or technologies that will probably affect the way you compute both in the near term and in the long run.

Some of the microprocessors in this chip medley are still in the conceptual or architectural stages. Some are in the process of being produced, and some are already helping businesses use their devices more efficiently.

Dealing with Logic That's Fuzzy

Currently, many of the most dynamic R&D efforts involve chaos, fuzzy logic, and neural networks. These techniques deal with ways of understanding and coming to conclusions about phenomena that are nonlinear in nature or aren't clear-cut enough for conventional computers to handle efficiently.

For example, the FC110 from Togai InfraLogic (see photo 1) is a digital fuzzy processor capable of performing generic microprocessor tasks. However, in a couple of ways (i.e., its instruction set and its chip specifications) this processor is geared to handle fuzzy logic information.

This chip's FZAND and FZOR instructions were designed to perform fuzzy AND and fuzzy OR operations. (For more information on fuzzy logic, see "When Facts Get Fuzzy," April 1988 BYTE). The following is an example of a rule that uses two premises. It is one of several rules used to demonstrate the balancing of an inverted pendulum.

```
Rule 1:  ;Clear the Alpha Register
         LOAD    #FF,ALPHA
         ;if(Theta == PM && dTheta == ZO)
         LHS     ALPHA, #2
                 Theta
                 Theta.PM
                 dTheta
                 dTheta.ZO
         ;Velocity = PM
         RHSC    ALPHA, CONCL
                 Velocity.PM
```

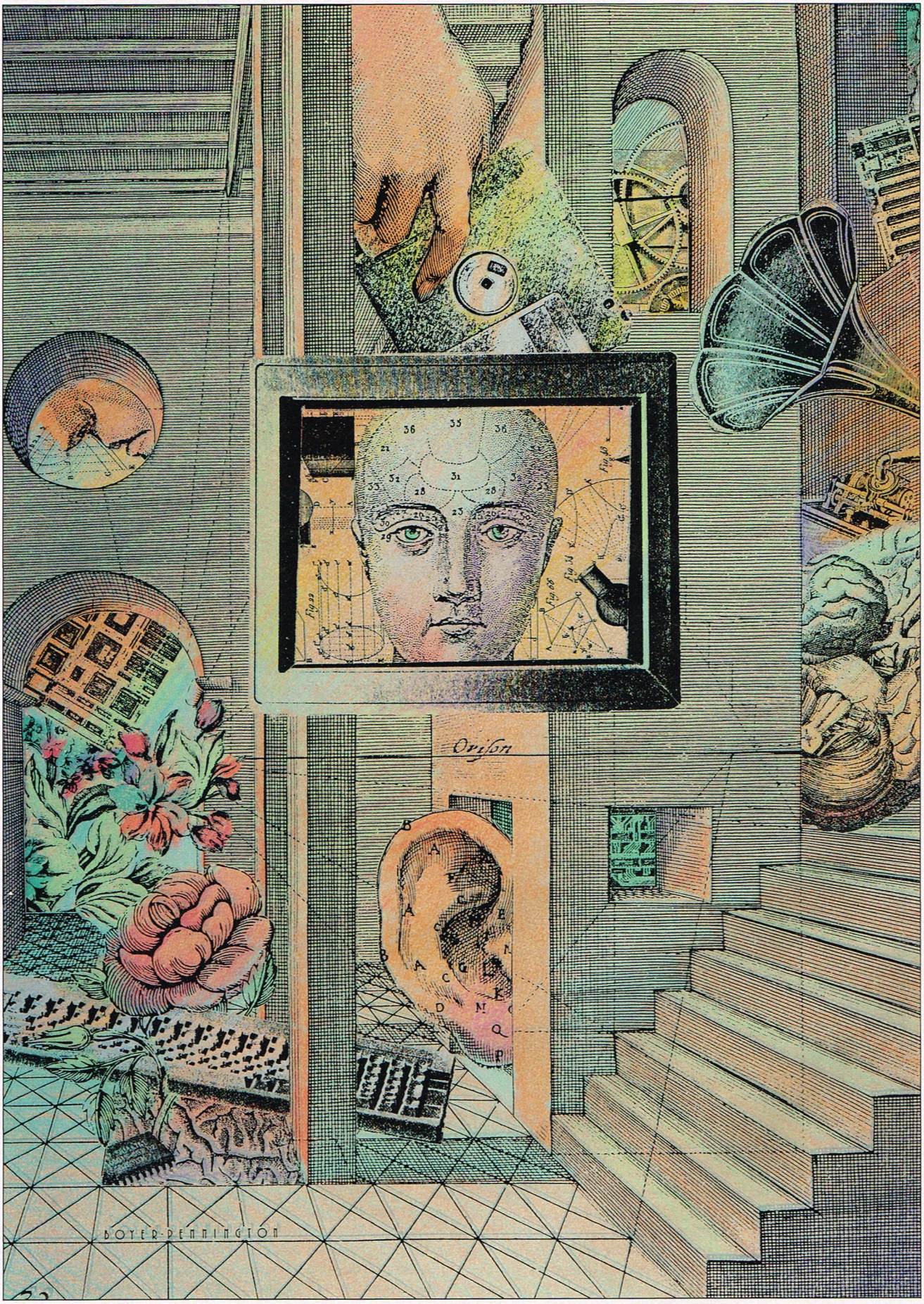
The FC110 is one of the few chips that has an instruction that evaluates the entire left side (IF condition) of such a rule. A single LHS (left-hand-side) instruction on the Togai processor handles up to 255 fuzzy membership tests (versus several instructions per test on chips not specifically developed for fuzzy-logic applications). The RHSC (right-hand-side by centroid) instruction evaluates the right side of the rule.

The data processing portion of the FC110 was also designed and sized to handle fuzzy-logic tasks. The processor runs at 10 million instructions per second (MIPS) and, although mainly an 8-bit chip, can perform 16-, 24-, and 32-bit (as well as some other) operations especially suited for fuzzy-logic problems.

Because of these features, Togai's processor is suited for applications requiring real-time performance, such as robotic joint/trajectory control, sensory fusion (combining the input from a variety of sensors), pattern recognition, and analytical and medical-instrument reading interpretations.

Cloning the Brain

Researchers have high hopes for neural networks as a potentially valuable processing technology. These artificial systems


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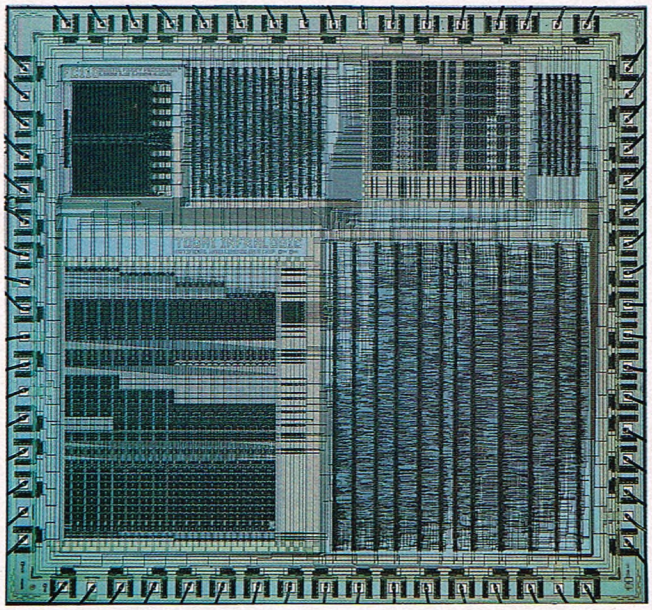


Photo 1: *The FC110. On the bottom left of the dye, the ALU path is set up so it will do 8-, 16-, or 32-bit operations. The large block at the lower right contains the hardware to implement the special instruction set that performs fuzzy-logic operations.*

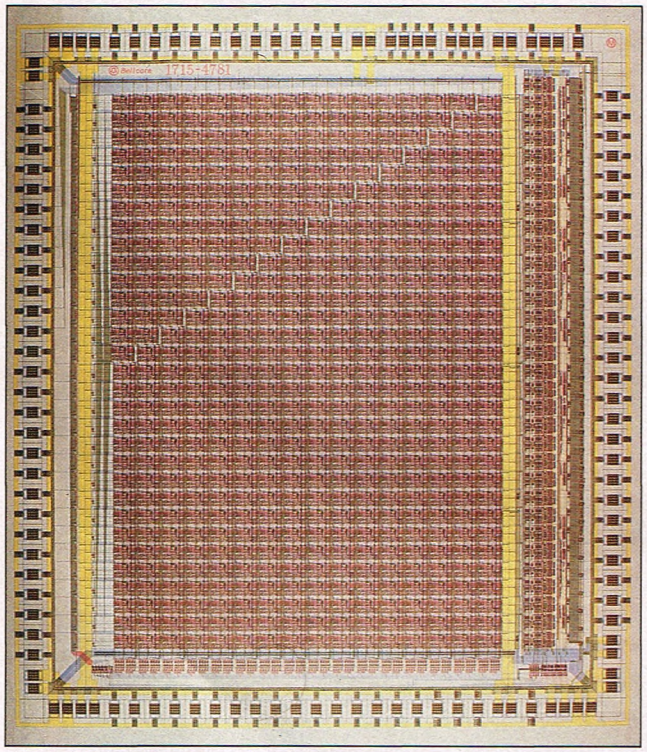


Photo 2: *This is a rendering of the Bellcore chip that contains three major functional areas: the noise generator (extreme right), the neurons (just to the left of the noise generator), and the synapse array (to the left of the neurons). Most of the chip is occupied by the learning synapse array.*

simulate how it is believed the human brain works, learning by example rather than having to be programmed. (For more information on neural networks, see the State of the Art section in the August 1989 BYTE.)

As of this writing, at least a dozen organizations claim to have produced working neural-network chips. In the last quarter of 1988, using VLSI technology, scientists at Bellcore (the research arm of the seven regional Bell holding companies) developed an analog neural-network chip. The purpose of this processor (developed for research purposes only) is to perform high-speed on-chip learning in parallel.

Recently, Bellcore's researchers enhanced the learning algorithm and produced a new version of the chip that can learn as well as evaluate information at the rate of about 100,000 patterns per second. There are 160,000 transistors and 496 bidirectional synapses (electrical connections between neurons) on the new chip (a 7- by 8-mm die). Each of these synapses has 5 bits of dynamic range and 32 neurons with variable gain. (A neuron is the nerve-cell body and all its processes.) The learning synapse array covers most of the chip (see photo 2).

This second-generation learning chip can perform 10^8 connections per second, as well as the same number of connection updates per second. Bellcore calls its neural-network processor a "cascadable" learning chip: It can be cascaded (arranged so that the output of one feeds directly into the input of another) for larger systems with no degradation in performance. A neural-network chip with this type of processing power and self-learning features can tackle hard-to-handle applications such as visual pattern recognition, speech synthesis and recognition, and network optimization and control.

Alternative Neural Network Approaches

It should come as no surprise that Intel has thrown its hat into the neural-network ring in a big way. The company has already produced one neural-network chip and is in the process of letting another company use some of its technology to produce a second chip. Intel also has a neural-network workstation in the prototype stage.

Intel used CMOS-III EEPROM technology and a 208-pin PGA (pin grid array) package to create its first neural-network device, dubbed an electronically trainable analog neural network, or ETANN (see photo 3). ETANN contains 64 analog processing elements and 10,240 trainable weights. It is currently being provided to system developers as an experimental chip for prototyping and research.

Because of its highly parallel architecture, the chip achieves a blazingly fast computation rate—roughly 2 billion multiply accumulates (interconnections) per second. Another feature of ETANN is that it uses floating gate storage (versus digital RAM elements or analog DRAM storage) for its weights.

Since it was Intel's first entry into the neural-network field, the company took a conservative approach by not adding a learning capability to the chip. Thus, you need some support tools to train ETANN. A PC-based simulation and training program from California Scientific Software (developer of the BrainMaker neural-network simulator) provides the learning capability.

ETANN's speed and parallelism make it good at mapping and character- and pattern-recognition. But because the chip has a memory limitation of about 10K bytes, it is not good at performing recognition tasks that require a large database.

This past spring, Nestor was awarded a $1.2 million contract from the Defense Advanced Research Projects Agency (DARPA) to develop a neural-network chip in conjunction with Intel. According to Nestor, the N1000 device will be capable of

processing 150 billion synapse interconnects per second and will function as a true learning device and parallel processor.

The inherently fault-tolerant N1000 will incorporate Intel's proprietary flash memory technology (see "Store Data in a Flash" on page 311). The N1000 will use an estimated 250,000 flash memory cells to implement a nonvolatile storage capability that is expected to provide 10-year data retention. Portions of the data path are parallel, and portions are multiplexed. One of the noteworthy features of the N1000 is that learning can be performed on-chip (as opposed to in software).

A chip as fast as the N1000 is ideally suited for applications such as speech, handwritten character and pattern recognition, machine vision, signal processing, on-board automotive diagnosis, and industrial process control.

Sniff Chip Coming

If the collaboration between the University of California at Irvine (UCI) and Adaptive Solutions is successful, a new chip will be born that can identify, discriminate between, and store odors.

The olfactory system was the evolutionary precursor to the rest of the brain's cortex. If Adaptive Solutions is able to translate a simulation of the olfactory cortex onto a chip, researchers may begin to understand other kinds of primary perception, such as vision, hearing, and touch. Understanding the olfactory system would be one of the first steps toward figuring out how the neocortical brain functions really work (the neocortex comprises 80 percent to 90 percent of the brain).

UCI scientists Richard Granger and Gary Lynch performed the research that resulted in programming a computer to duplicate the wiring of neurons in the olfactory cortex. "Identifying smells is a tentative first step toward circuit designs that may emulate those in our heads," says Granger. As the simulation receives the computer equivalent of smells, it stores memories by creating a hierarchy of categories and sorting the sensory information into finer classifications with each "sniff."

Currently in architectural form, this neural-network processor will learn with on-chip hardware. You will be able to tweak the chip to work with any neural-network learning model by reconfiguring its microcode. Tasks will be distributed among an array of parallel processors that can process up to 300 million connection updates per second during learning. The chip will hold a single layer of processing nodes, which are time-shared among all the virtual connection nodes in a network (see figure 1). (A virtual node concept uses time-division multiplexing to simulate all the layers in a particular network, one at a time.)

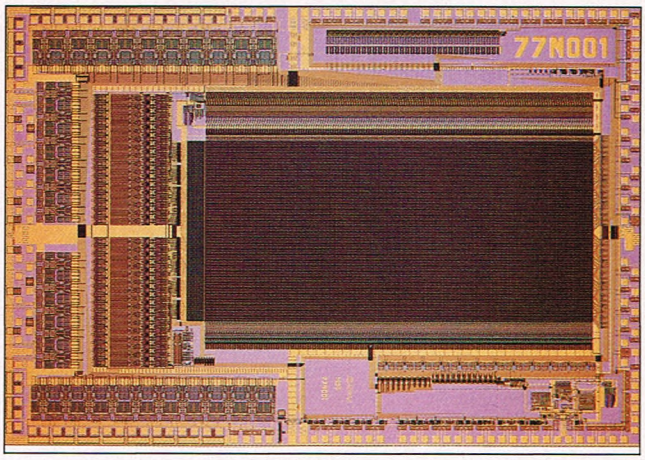


Photo 3: *Intel's nonvolatile ETANN chip provides permanent true analog weight storage without refresh or battery backup. Its 10,000 multipliers and 20,000 analog EEPROM cells take up the bulk of the dye area.*

Help for Your Shrinking Desktop

Are you getting the feeling that space on your desktop is shrinking in direct proportion to the number of imaging devices becoming available? Wouldn't it be nice to be able to replace all

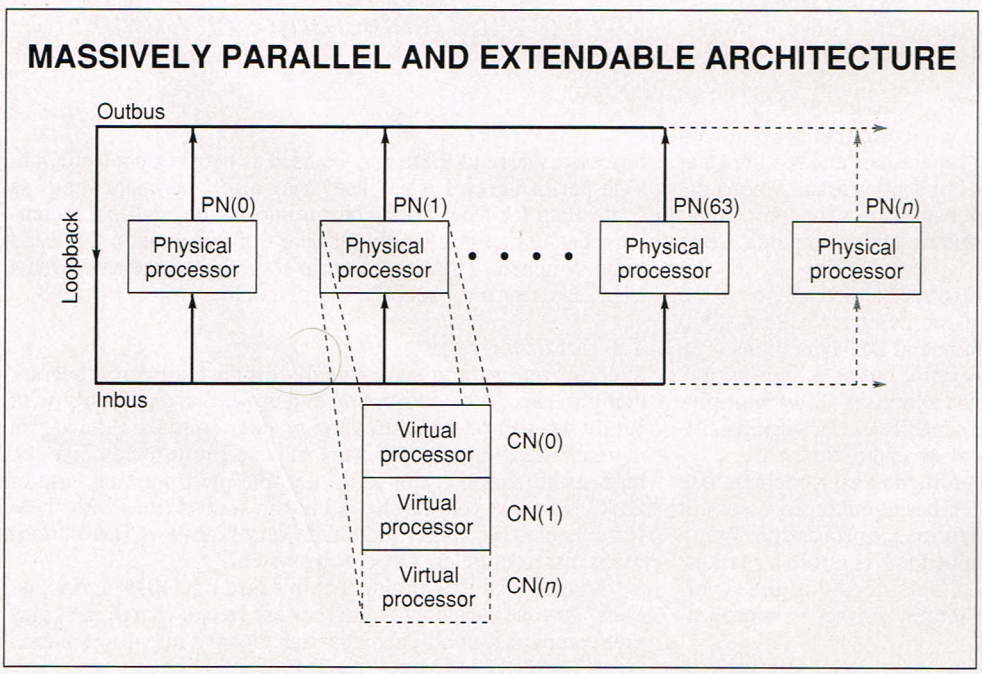


Figure 1: *Adaptive Solutions' architecture can be extended in two directions. Each chip has 64 processor nodes, and additional chips can be added to provide arrays of hundreds of processors. Virtual processors, called connection nodes, are mapped to each physical processor, creating thousands of neural-network nodes. Loopback techniques and broadcast from any processor allow arbitrary interconnection of all nodes.*

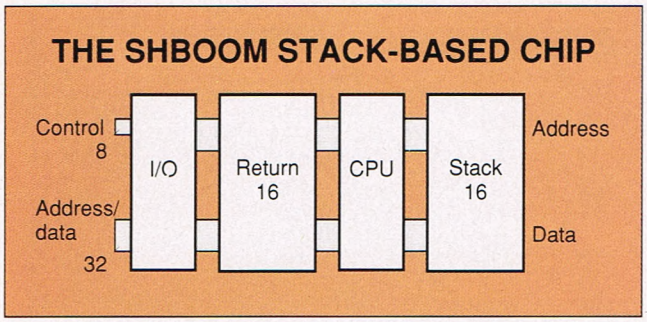


Figure 2: *ShBoom has separate 32-bit internal buses for address and data. Both access the CPU, its two stacks, and the I/O processor. These buses are multiplexed into a single 32-bit external bus with DRAM and I/O control signals.*

the clutter with a single box that (with the addition of special software) would let you scan, copy, and print documents; desktop publish; communicate via fax, voice, and E-mail; transmit data; and be networked to your entire workgroup?

A sophisticated chip from National Semiconductor can perform all these imaging functions. Tagged the NS32GX320, the chip was designed for computation-intensive, embedded-control applications. Concurrent processing, digital signal processing (DSP) instructions, and a two-channel DMA controller are features of this new member of National Semiconductor's family of embedded system processors.

The 32-bit chip's internal organization allows a high degree of parallelism in executing instructions, on-chip BitBlt instruction primitives and logic, stack instruction syntax tuned for PostScript execution, and a two-way set-associative data cache for character generation. The NS32GX320 integrates more than 390,000 transistors that are fabricated in submicron, double-metal CMOS technology and, according to National Semiconductor, achieves a peak performance of 15 MIPS.

This microprocessor was designed for applications such as embedded control of high-performance laser printers, intelligent terminals, and solid-state phone answering. It can also act as a controller for fax machines (including Group 4 ISDN), scanners, or multifunctional combinations of both.

Stack 'Em Up and Go Forth

A stack-based processor has an architecture that is optimized for real-time control with specific capabilities and features that make that type of operation its best application area. Among the companies that are preparing stack-based chips for commercial production are Harris Semiconductor and Computer Cowboys.

One of the newest chips from Harris Semiconductor is the RTX 2010. This enhancement of the company's RTX 2000 chip will be able to run floating-point and DSP operations. The 2010 was not designed as a 32-bit chip, but as a high-performance 16-bit microprocessor. It has a built-in 48-bit multiply-accumulator that provides its DSP capabilities. In working silicon now, Harris's 2010 is due out at the end of this year.

Why do a stack processor? According to Phil Koopman, one of Harris's leading experts on stack-based microprocessors, it fills the need for low-cost, low-performance processing. Why a stack-based processor for the embedded controller market? Again according to Koopman, "Outside the highest-volume product, DRAMs, the next largest market is microcontrollers."

Because they are stack machines, both the Harris and Cowboy Computer chips run Forth well. Why Forth? A characteristic of high-level machines is that they were optimized for a particular language to the exclusion of being able to run other languages. Forth makes a natural assembly language for a stack machine, but, if you wish, you can also work in C instead of an assembly language. Both companies offer an ANSI C.

Although both chips are stack-based, Chuck Moore (computer pioneer, software innovator, and creator of Forth) went down a different trail with his ShBoom chip. He designed it to be a 32-bit chip with two processors—each with its own instruction stream, sharing memory. An I/O processor directs time-synchronous data transfers while the CPU asynchronously runs the ALU. A low-power (100 milliampere) CMOS microprocessor, Moore's chip was designed for an inexpensive, fast (1-megabyte, 200-MIPS peak speed) computer. It has 8-bit instructions so that each 32-bit word is a 4-instruction cache.

Figure 2 shows the chip's external 32-bit address and data bus interfaced to its internal 32-bit address and data buses. These buses link the stack caches, the CPU with its registers, and the ALU with the I/O processor and its registers. At power-up, the I/O processor writes 32-bit data into DRAM after four reads from 8-bit ROM. With this bootstrap, additional data can be loaded from ROM, disk, or serial line.

This type of chip may be used in areas such as storage and transfer of data as well as communications. Stack-based microprocessors such as these may be used as network controllers in high-performance LANs. They may also find applications as controllers for fiber-optic concentrators with multiple incoming fiber-optic lines handling packets of information that need to be switched. This type of chip responds to external events (e.g., catching a packet off a LAN) quickly.

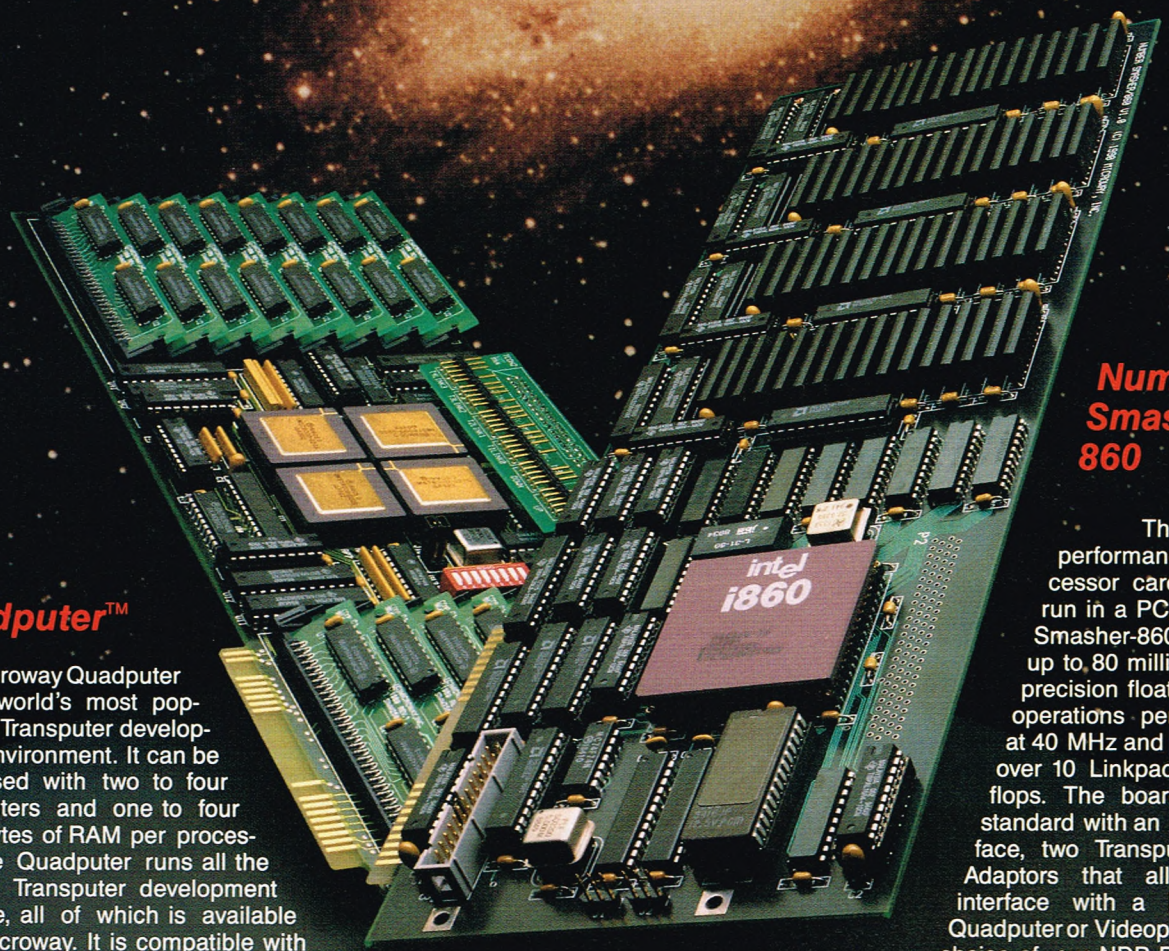
This prototype may show that digital GaAs is ready for ultralarge-scale ICs and that it is possible to build GaAs logic circuits that will operate over a wide temperature environment.

TRON Offspring

Suppose you want to economically produce a microprocessor that provides 32-bit addressing and upward compatibility with future 48- and 64-bit addressing modes. To make things even more challenging, say you want the end result to combine the high-speed simplicity of RISC and the programming ease of CISC. How do you develop a chip in record time with these features plus the ability to include very high-level instructions useful for a compiler or operating system?

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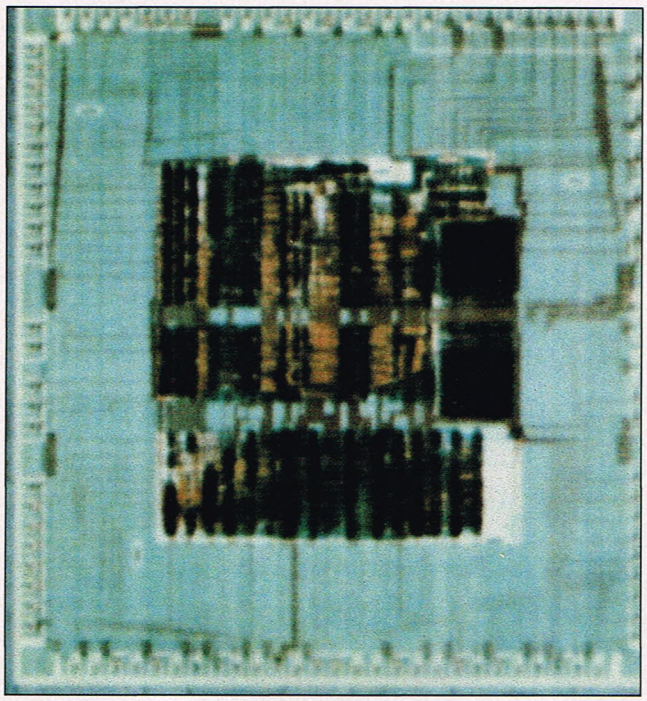


Photo 4: *The first 32-bit GaAs RISC microprocessor. Demonstrated in September 1988, the chip had 13,000 TTL gates. Improvements have led to 10-times-faster gates and yields to support 30,000 gates.*

TRON (for The Real-Time Operating System Nucleus) is a standardization effort consisting of an open architecture, a family of VLSI chips, and system software. Although it is a recently implemented concept developed by Ken Sakamura of the University of Tokyo, several companies have already based processors on its specifications. Mitsubishi is one such company, with its new family of M32 embedded controller microprocessors.

One of Mitsubishi's TRON-based chips, the M32/100, has been optimized for any control application requiring general performance rates between 8 and 12.5 MIPS at 25-MHz clock rates. Due to its instructions for bit-mapping operations, this chip is a suitable 32-bit CPU for applications with graphics requirements. The M32/100 shines in areas such as laser printers, X Window System terminals, and telecommunications.

Although currently produced with 1.0-micron technology, by the end of this year this chip is due to be fabricated with 0.8-micron process techniques. Because of its TRON heritage, the M32/100 provides a good application-specific IC core so that, with the addition of application-specific hardware, users can achieve an economical system-specific solution.

First of the GaAs Chips

Coming soon will be microprocessors fabricated from gallium arsenide (GaAs) instead of silicon, and possibly hybrid chips that are a combination of these and other materials.

Texas Instruments (TI), one of the major innovators in the microprocessor industry, has in the prototype stage a DARPA-funded GaAs chip that has demonstrated some very impressive potential capabilities. At a DARPA symposium held last year, this chip was touted as being the world's fastest 32-bit CPU (see figure 3).

TI's speedy 150-MHz pipeline RISC processor, with six pipeline stages, uses heterojunction-based bipolar technology, which is faster but more complex and expensive than conventional MESFET (metallic Schottky field effect transistor) technology (see photo 4). According to company officials, this chip's nearest competitors are 80-MHz, 20-watt microproces-

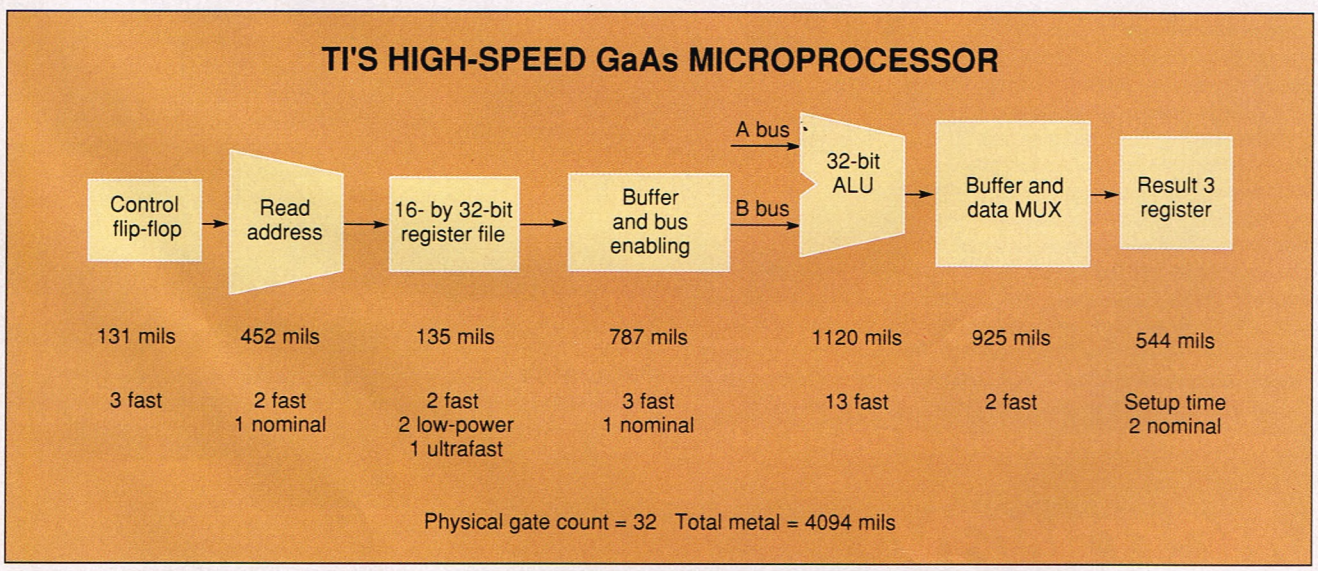


Figure 3: *This critical path analysis shows the trade-offs made in TI's chip between speed and power requirements (which are directly proportional in GaAs technology). Propagation delay due to metal interconnects is significant, increasing the critical path delay by 25 percent. Note that the design concentrates 13 fast gates at the ALU, where a 1120-mil interconnect would otherwise slow processing significantly.*

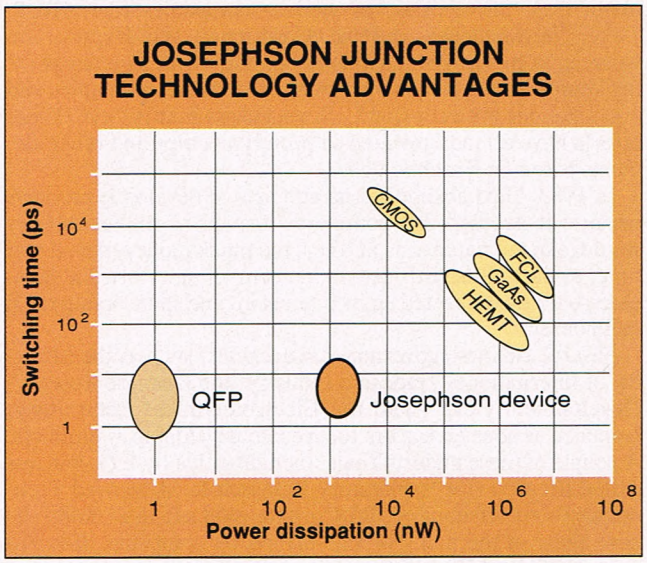


Figure 4: *A comparison of switching time and heat-generation between several kinds of circuit elements. Note the orders of magnitude difference between those that use Josephson Junction technology and those that don't.*

sors. TI's prototype is a 13,000-gate microprocessor (equivalent to a CMOS chip with 50,000 transistors).

TI has built and tested this 16,000-gate-equivalent logic gate device; emitter coupled logic usually runs in the 15,000-gate to 20,000-gate range. The processor contains a 32-gate-delay critical path with 200-picosecond-per-gate delays. More typically, high-speed processors contain a 20-gate-delay critical path with 650 ps-per-gate delays. This 20-gate-delay path length in GaAs would have required memories in the 1.5-nanosecond range, which is considered too demanding for current memory technology.

Some of the first applications for this high-speed processor will be in military guidance systems where there is space for only one processor and it must do the work of six less-powerful chips. The TI GaAs offering will also lend itself to DSP and other very high data rate applications.

This prototype chip offers many advantages, such as its small size and light weight. It has also been shown to be highly reliable and to offer reproducible performance. And, for logic and processing tasks, GaAs is faster than silicon.

However, since TI's chip hasn't yet been commercialized, with the resultant optimization of its good features, it still has some disadvantages, as well. Although it will perform three times as fast as silicon chips, it will also cost three times as much. Another disadvantage is that, at this point, the processor does not contain much memory. GaAs is an intrinsically poor technology choice for microprocessor memory, compared to BiCMOS.

Nevertheless, hopes are high for this high-speed, high-performance microprocessor. This prototype may show that digital GaAs is ready for ultralarge-scale ICs and that it is possible to build GaAs logic circuits that will operate over a wide temperature environment.

Toward Smaller and Faster Machines

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COMPANY INFORMATION

Operational data on the chips discussed in this article was provided by the manufacturers. For more information, contact the companies listed below.

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alternative technologies. Processors developed using Josephson junction (Jj) superconducting technology stand a good chance of being serious contenders.

Jj technology is based on the use of tunnel junctions (a kind of quantum-mechanical switch) made with a thin layer of insulating material. This insulator is sandwiched between layers of a superconducting material cooled to an extremely low temperature. Liquid helium is the coolant that is currently used. Jjs can switch voltages extremely quickly while consuming only a small fraction of the energy that conventional devices need (see figure 4).

On the road to developing smaller and faster computers that feature high switching rates and very low power consumption, many U.S. universities, as well as companies like AT&T, TRW, Westinghouse, duPont, Conductus, and Hypres, are working with superconducting technology. But superconducting ventures undertaken by dozens of Japanese companies and organizations are eclipsing U.S. endeavors in this field. These efforts have already resulted in prototype chips and other elements based on Jj technology.

In 1983, IBM abandoned its attempts to develop Jj products because it decided that commercialization of the technology would take too much time and cost too much money. About that time, as part of its fifth-generation computing effort, the Japanese government beefed up its interest in, and sponsorship of, Jj technology.

Several Japanese governmental agencies, such as the Ministry of International Trade and Industry, the Japanese Research Development Corp., and the Electrotechnical Laboratory, launched serious endeavors focused on developing Jj products. A couple of these undertakings, including that by ETL and one called ERATO (for Exploratory Research for Advanced Technology)—an offshoot of JRDC—have paid off in Jj chips. So have some of the many private efforts by companies like Fujitsu, NEC, and Hitachi.

ETL has reportedly developed a 1-kilobit Josephson memory chip in which 90 percent of the cells can be accessed by the peripheral circuit. ETL has also announced completion of a four-chip, Jj-based RISC microcomputer that processes most instructions in 1 ns and consumes only about 6.2 milliwatts (mW) of power.

ERATO is taking a new look at a device called the quantum flux parametron, developed about 30 years ago, that uses the Josephson junction. QFP researchers are exploring the possibility of producing an ultrafast computer using this technology.

Fujitsu has demonstrated a single-chip, 4-bit Jj microprocessor with roughly 3000 gates and approximately 12 instructions stored in an on-chip ROM module. Its maximum clock frequency is said to be 1.1 gigahertz, with a minuscule energy consumption of only 6.1 mW. Hitachi has also reported having developed a microprocessor similar to Fujitsu's in complexity and performance.

This past spring, NEC scientists announced development of a 4-kilobit Josephson memory with a memory read-out time of 580 ps (0.58 ns). Comprising about 25,000 Josephson elements, the NEC chip measures 5 mm square, with a cell size of 55 microns square.

A Ticket to Tomorrow

With the advent of new superconductive materials that can be used with higher-temperature coolants (liquid nitrogen, for instance), a number of experimental Jj processors, switches, A/D converters, and even computers are arriving on the scene. At the moment, niobium and niobium nitride are the most promising superconductors of choice, while aluminum oxide, niobium oxide, and manganese oxide are the three most commonly used insulators.

Many difficult material problems (as well as a lack of progress in related memory technology) remain to be solved. But scientists may produce the next generation of chips and computers using Jj, SQUID (for superconducting quantum interference device), and QFP superconducting techniques. Circuits using these technologies may run faster, use less power, occupy less space, and in other ways outperform their conventional electronic counterparts. ■

Janet J. Barron is a technical editor for BYTE. She can be reached on BIX as "neural."

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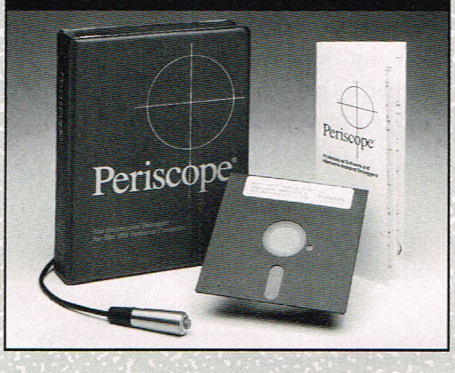
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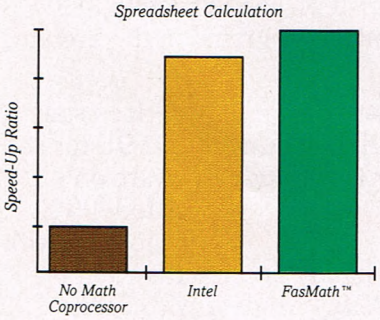
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MODEM BUSINESS

A close look at the Bell and CCITT standards for modem communications

Steven E. Turner

Sending and receiving files over modem connections is a routine procedure for most personal computer users. It's not unusual, however, to find modems that can't communicate effectively because of compatibility problems—they don't all follow the same standards.

For users, just *understanding* modem standards can be a problem. The maze of modem standards grows constantly. Look at modem advertisements and you'll see a long list—Bell 103J, Bell 212A, V.22, V.22bis, V.32—not to mention proprietary technology and protocols that are licensed by individual companies.

These standards cover a variety of transmission speeds and such features as error correction and data compression. The modem standards in use today come primarily from three sources: Bell Standards, CCITT Recommendations, or EIA/TIA Standards. (For definitions and an explanation of how modem standards are established, see the text box "Where Modem Standards Come From" on page 354.) Table 1 shows the most common modem standards for data rates of from 300 bps to 14,400 bps, over leased-line and dial-up telephone lines.

Low-Speed Standards

The most common low-speed standards in use are the Bell 103J standard for 300-bps transmission and the Bell 212A standard for 1200-bps transmission. Almost every modem sold in the U.S. supports these standards, either as the primary rate or as secondary *fallback* rates. Fallback rates are used when the modem is unable to connect at higher rates, usually because the telephone channel is too noisy to provide error-free communication at that rate. For example, if a modem attempts to connect at 2400 bps but determines that the line will not support that rate, the modem may try to connect at 1200 bps or 300 bps instead.

The Bell 103J and 212A standards are two-wire, full-duplex standards. This means that modems that support those standards use ordinary telephone lines, and they transmit and receive data in both directions simultaneously. Even at 1200 bps (212A), the data rate is low enough that the data channel for both directions of transmission can fit comfortably within the 3000-Hz-wide voiceband telephone channel.

Because the CCITT was developing international standards during the 1960s (while Bell was defining U.S. standards), most 1200-bps modems in the rest of the world operate using a standard known as V.22. This is similar to the Bell 212A standard, but the carrier frequencies at which the data channels are modulated are different. Thus, V.22 modems and 212A modems are not compatible, unless special design changes are incorporated.

For 2400-bps transmission, most personal computer modems in use today implement V.22bis. The Bell Standard for 2400-bps data was never completely accepted, because at the time the telephone company's monopoly was dissolved, 2400-bps transmission wasn't yet perfected. As a result, there is almost universal compatibility among 2400-bps modems based on V.22bis.

Like the lower-speed standards, V.22bis is a two-wire (dial-up line), full-duplex standard. To fit two 2400-bps data channels in the 3000-Hz-wide voiceband telephone channel, the data bits are encoded into 4-bit bytes before transmission. Each data signal is then transmitted at 600 baud, and the two modem channels can again fit comfortably within the telephone-line channel.

High-Speed Standards Grow

Prior to 1984, modem transmission at speeds above 2400 bps was possible only by transferring the data over expensive four-wire (leased) telephone lines. Special standards, such as Bell 208 for 4800 bps, V.29 for 9600 bps, and V.33 for 14,400 bps, were available for use with these leased lines. However, only users needing to transfer very large amounts of data could justify the cost of leasing the telephone lines and buying the more expensive modems.

In 1984, the CCITT approved V.32 for use with standard

Where Modem Standards Come From

To grasp the conglomeration of modem standards, some understanding of where they come from and how they are made is important. The modem standards in use today come primarily from three sources. The modulation and coding standards are normally Bell Standards or CCITT Recommendations. The interface standards are either CCITT Recommendations or Electronic Industry Association/Telecommunications Industry Association (EIA/TIA) Standards.

The Bell Standards are holdovers from the 1960s when all domestic modem standards were set exclusively by the telephone company. In those days, the telephone company had a monopoly on anything connected to its lines, and, by law, it was the only one allowed to sell modems. As a result, it set its own design standards.

The 1968 Carterphone court decision opened the door for other manufacturers to begin making modems, and the method of standards-making changed. Since modems used in other countries at that time generally followed international standards, U.S. manufacturers became involved in helping develop those standards instead of creating a new set of standards specifically for the U.S.

Today, most new modem standards are created by the CCITT, based in Geneva, Switzerland, and affect modem users worldwide. In the U.S., modem experts participate in national standards development groups, such as the TIA, to create those standards needed solely for U.S. interests. They also generate technical papers and proposals for the international CCITT organization and join technical experts from other countries in attending CCITT meetings.

Together, these groups work out the fine details of new international modem standards. However, when it comes time to vote on the new standards, each member country is granted only one vote. An official of the U.S. Department of State (the formal representative to the CCITT) casts the U.S. vote.

Many standards efforts never make it to a vote because of technical problems or political snags along the way. As a result, those that do reach approval are usually well-tested and proven techniques that can be applied around the globe. Once a standard is adopted by the CCITT, modem makers begin implementing it in their products.

One interesting feature of CCITT "standards" is that they are called *Recommendations*. The CCITT cannot force modem manufacturers to comply with its procedures; rather, it recommends an approach. However, in many countries where the telephone network is operated exclusively by the government, CCITT Recommendations have the full force of telecommunications law. In such cases, all modems connected to the network must comply explicitly with the appropriate CCITT Recommendations. In practice, worldwide adherence to CCITT Recommendations is the norm.

dial-up telephone lines. V.32 leapfrogged from 2400 bps to 9600 bps, representing a 4-to-1 increase in throughput over modems using V.22bis. Using advanced technology to provide 9600-bps transmission over ordinary telephone lines, V.32 put the everyday personal computer user in the high-speed data business for the first time by opening new doors to sharing files and programs rapidly over modem connections.

V.32 Specifics

The technology required to implement V.32 modems did not come easily. The level of technical expertise needed in developing V.32 modems has been conservatively estimated to be 100 times greater than for V.22bis modems. As a result, fully functional V.32 modems did not become widely available until late 1986—two years after V.32 was adopted.

To send 9600-bps data, V.32 modems group the data into 4-bit bytes and transmit them at 2400 baud. Since there is room for only one 2400-baud data channel within the 3000-Hz-wide telephone channel, V.32 calls for both modems to transmit over the same channel at the same time. Each modem must then sort out its own transmitted signal from the signal it is receiving from the other modem. To do this, V.32 modems use *echo cancelers*. Figure 1 shows a typical modem connection, with the echo cancelers included in the modems at each end.

Hybrid circuits inside all modems are designed to match the characteristics of the modem to the telephone line. Since the nature of the telephone network changes constantly, this match is never ideal. This results in part of a modem's transmitted signal being reflected through the hybrid and back into the modem's receiver.

In addition, echoes of the transmitted signal from the hybrid circuits out in the telephone network bounce back into the modem's receiver. To get a good strong received signal, these reflected echoes must be removed before the modem receiver processes its input.

The echo canceler, which is driven by the known transmitted signal, models the echoes produced by hybrid circuits in the modem and the network. The output of the echo canceler is subtracted from the received signal before it goes into the modem receiver for processing, thus eliminating the effects of the echoes. This is not a simple task. The precision that is required in the echo canceler to remove the echoes is substantial. Since the transmit signal is constantly fluctuating with changes in the data, the echo canceler must continuously adapt to those

MODEM STANDARDS

Table 1: *Many standards and recommendations govern how modems are designed. These standards allow modems from many different manufacturers to communicate with one another. An asterisk indicates "with echo cancellation."*

Data rate (bps)	Standard	Line	Duplex
300	Bell 103J	Dial-up	Full
1200	Bell 212A	Dial-up	Full
	Bell 202	Dial-up	Half
	Bell 202	Leased	Full
	CCITT V.22	Dial-up	Full
2400	CCITT V.22bis	Dial-up	Full
	CCITT V.26ter	Dial-up	Full*
4800	Bell 208	Leased	Full
9600	CCITT V.29	Leased	Full
	CCITT V.32	Dial-up	Full*
14,400	CCITT V.33	Leased	Full

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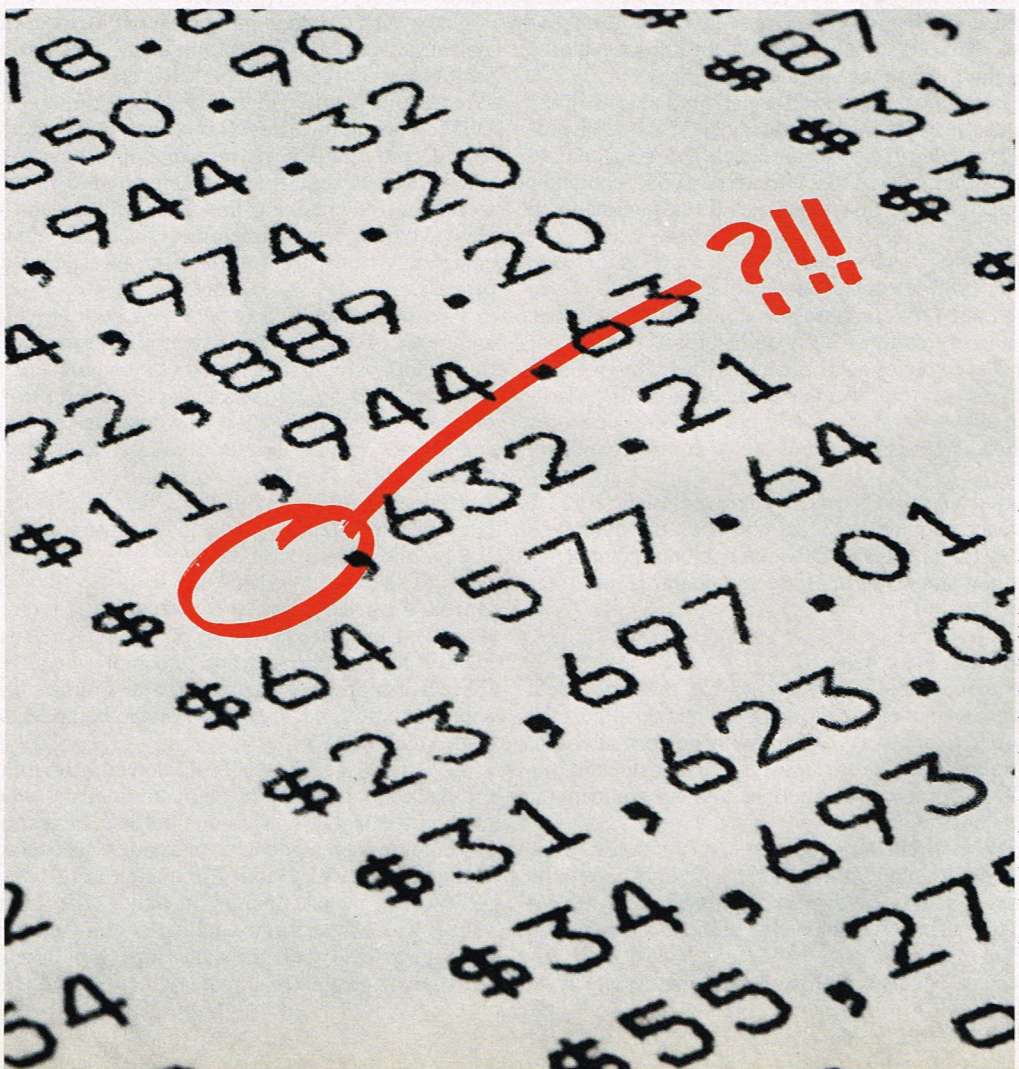
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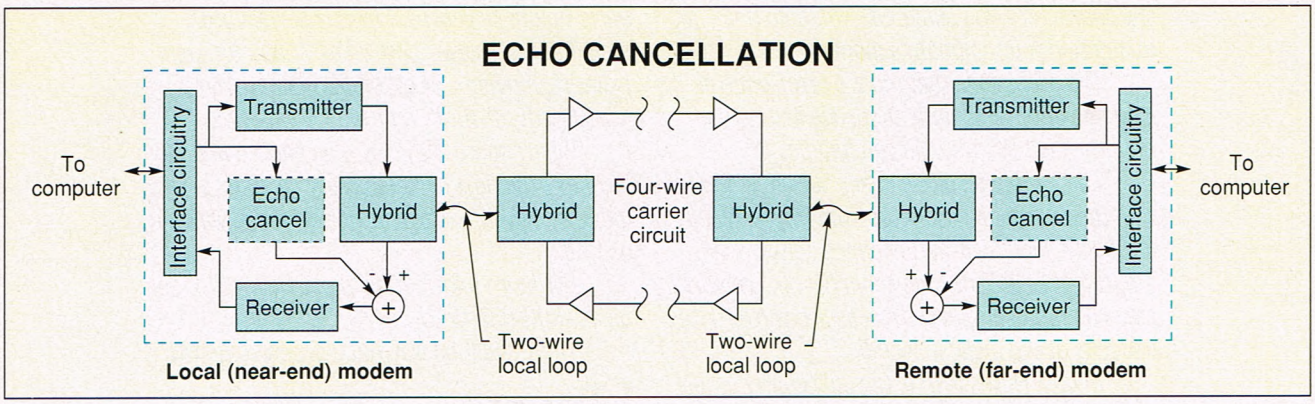


Figure 1: *In all modem connections, the computer output signal is sent directly to the modem for transmission over the telephone line. A typical dial-up telephone-line modem connection requires the modem signal to pass through two-wire local-loop channels to the telephone company's nearby central office. From there, it travels over a four-wire circuit to the other end of the connection. The signal then passes through the distant modem's receiver to the computer at the other end. Hybrid circuits connect the two-wire/four-wire links and isolate the transmit and receive signals in the modems. In high-speed modems, such as V.32 modems, an echo canceler is used to further isolate the transmit and receive signals and improve signal reception.*

changes as it mimics the transmitted signal's echo.

Since at any given moment a V.32 modem is transmitting more data than a lower-speed modem, the individual V.32 data signals are much weaker and harder to detect. For this reason, V.32 incorporates advanced coding techniques such as *trellis encoding*. Trellis encoding allows the modem to examine several consecutive received signals and look for known patterns before deciding the value of the signal.

This memory effect can produce dramatic reductions in the error rate. The end result is that well-made V.32 modems produce very low error rates and provide reliable, high-speed data transfer between modems. This allows personal computer users to trade programs and download files at rates unimagined in the early 1980s.

In an attempt to push technology barriers even further, the CCITT began, in 1989, to study the idea of extending V.32 up to a 14,400-bps rate. This standard was named V.32bis, since it represented an outgrowth of V.32 rather than a new idea. V.32bis requires even better echo cancelers than does V.32. It also requires an overall improvement in receiver quality. Testing has shown, however, that 14,400-bps transmission over standard telephone lines is quite feasible with proper modem design.

V.32bis is expected to be formally approved by the CCITT by mid-1991. Once adopted, V.32bis will open the door even wider for very fast data transfer between personal computers. A summary of new and evolving modem standards and their status is detailed in table 2.

Data-Manipulation Standards

With the basic modulation rates approaching the theoretical limits of telephone-line channels, modem makers and the CCITT have turned to new ways of improving performance and increasing the data rates. The two most important steps in this direction are V.42 for error correction, and its companion, V.42bis, for data compression.

The error-correction and data-compression functions are applied to the data before modulation and stripped off before the modem receiver decodes the data at the other end. An expanded view of these functions inside the modem is depicted in figure 2.

At high speeds, modems are prone to making more errors, not only because of the reduced power in high-speed modem signals, but also because they use the edges of the bandwidth (which tend to be noisier) to carry data. V.42, formally approved in 1988, provides error correction using the automatic repeat request (ARQ) principle.

Under ARQ, data is grouped into blocks at the transmitter, and an advanced cyclic redundancy check is applied across each block. This is the same CRC concept already used to ensure the integrity of file transfers in techniques such as XMODEM. The main difference is that V.42 provides error-corrected operation for all information exchanges, not just file transfers using specific computer software programs. Since the technique for checking the received data and retransmitting flawed blocks is contained directly in the modem itself, it is completely transparent to the user and speeds up the transfer process.

The main drawback of V.42, as with any error-correction technique, is that when numerous errors are detected, the throughput rate suffers as blocks of data are retransmitted. However, this only comes into play when errors are actually present, and even then the slowdown in the transfer rate is a small price to pay for the capability to identify and correct those errors.

Modems equipped with V.42 were originally introduced in late 1988 in V.22bis products. It is now widely available in V.32 modems as well.

Data Compression with V.42bis

Approved in late 1989, V.42bis provides the first "official" method for compressing and decompressing data in modems. (Several proprietary compression techniques have been available for some time, the most notable being Microcom's MNP level 5 technique.)

As with V.42, the CCITT adopted a technique similar to those already in use in the computer industry when it selected a method for V.42bis. This method is a variant of the Lempel-Ziv compression algorithm, the same type of compression used in the familiar .ARC and .ZIP techniques.

However, instead of applying only to files compressed in advance, V.42bis performs automatic, real-time compression and decompression on all the data flowing between the modems. This can bring about dramatic reductions in the amount of time



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NEW AND EVOLVING STANDARDS AND RECOMMENDATIONS

Table 2: *The U.S. TIA and international CCITT committees continue to develop new modem recommendations. Here is a list of recent recommendations and important ones currently under development. The V.32bis Recommendation will likely be approved in mid-1991; it will provide for 14,400-bps file and data transfer over standard telephone lines.*

Standard	Purpose	Status
CCITT V.32bis Fallback Procedure	Provides a standardized way of negotiating fallback data rates from 14,400 bps down to 2400 bps.	Technically agreed upon but not yet formally adopted.
U.S./TIA Fallback Procedure	Provides a standardized way of negotiating fallback data rates from 14,400 bps down to 300 bps, including the Bell 103J standard.	Under study by the U.S. TIA TR-30.1 Committee.
CCITT V.32bis Recommendation	Provides standardized dial-up modems at rates of up to 14,400 bps; an extension of V.32.	Under study by the CCITT Study Group XVII Committee. Possible approval by mid-1991.
CCITT V.42 Recommendation	Provides standardized error correction in modems via either MNP Level 4 or LAPM (Link Access Procedure for Modems) protocol.	Approved, April 1988.
CCITT V.42bis Recommendation	Provides standardized data compression in modems via a version of the Lempel-Ziv data-compression algorithm.	Approved, September 1989.
CCITT 19.2K-bps Dial-Up Modem Recommendation	Provides standardized dial-up modem communications at rates of up to 19,200 bps.	Under study by the CCITT Study Group XVII Committee.

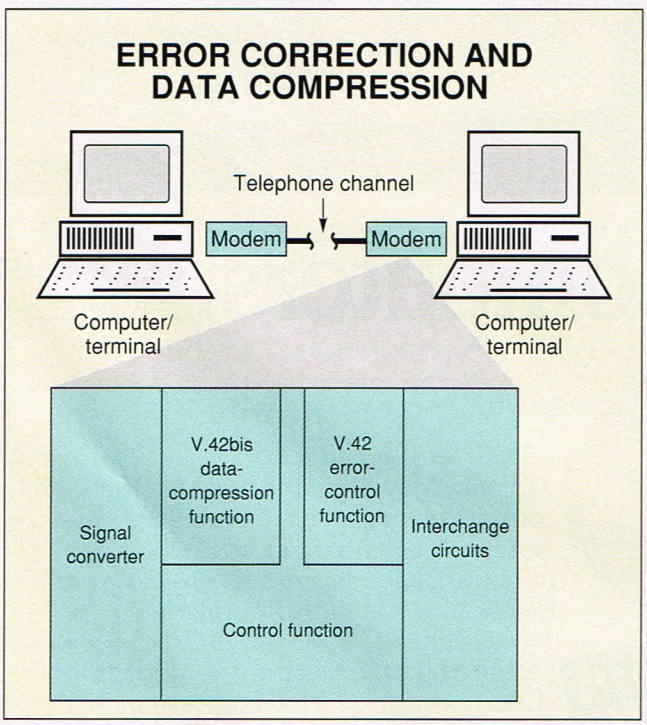


Figure 2: *Many new modems now use the CCITT V.42 error-correction and V.42bis data-compression Recommendations. In the modem, these functions are located in the overall control processor and are applied to the signal between the computer and the signal converter (modulator/demodulator). Modems at both ends of the connection must have V.42 and V.42bis capability for these features to be used.*

needed to send and receive data. For example, it is possible to achieve up to 4-to-1 compression ratios with V.42bis. That could mean effective rates of up to 38,400 bps with a V.32 modem or rates even greater than the 56,000 bps offered by digital leased-line service when used with a V.32bis modem. The advantages of reducing the time required to transmit files across a modem connection by a factor of four are obvious, especially if the telephone call is long distance.

The amount of compression that V.42bis can actually provide depends on the type of data being transmitted. Compression algorithms work by recognizing repeated patterns in data and substituting shorter symbols for them. This reduces the number of characters needed to represent a given set of information. The more repetition a data file has, the greater the compression. On the other hand, purely random data contains no patterns at all, and it is noncompressible.

Figure 3 provides a comparison of how well V.42bis works on various types of data. Assembly language and computer source code contain many short, repeated commands, since the language has a limited command set. As a result, data compression ratios on these types of files are generally quite high. Conversely, precompressed files such as .ARC or .ZIP files have already been processed to remove redundancy. Passing them through V.42bis usually does not provide much more improvement. Data files that have been encrypted through a randomization process will also show little reduction in file size and transmit time, because the data has been preprocessed to remove identifiable patterns. For the average personal computer user, however, V.42bis should reduce modem signaling time and expense considerably.

V.42bis began appearing in modem products this summer, first in V.22bis modems and later in V.32 modems. Many of the first V.32bis modems will have V.42bis compression capability as soon as they hit the market.

V.42bis relies on V.42 for its modem protocol and control

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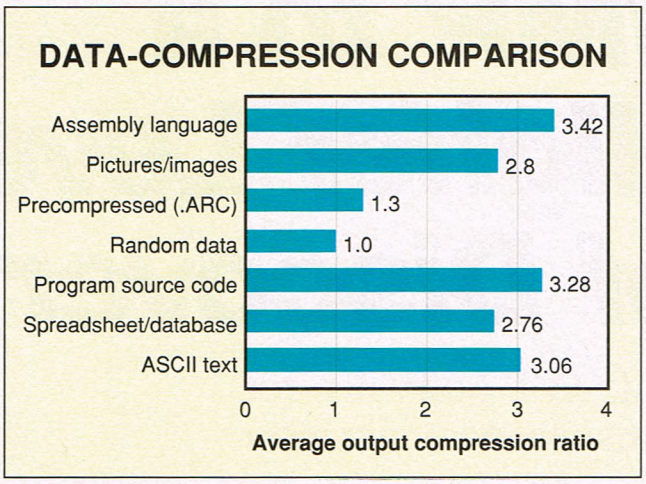


Figure 3: *The amount of data compression that V.42bis can provide depends on the type of data being sent between the modems. The more random the data, the less the compression, since truly random data follows no clear pattern. Data that has lots of repetition (such as text, source code, or pictures) can often be highly compressed. A compression ratio of 2.0 on this chart indicates that the data can be compressed by a factor of 2 and transmitted in half the time needed to transmit it uncompressed.*

functions. Because of this, only those modems that have V.42 will contain V.42bis. Fortunately, since V.42bis is a software-intensive technique, it doesn't require extensive modem redesign, and most modem makers are offering it in their products at a minimal increase in cost.

Standards to Watch For

The CCITT is continuing to develop new modem standards, pushing the technology envelope a little further each time. A new effort is under way to standardize a 19,200-bps modem. Another CCITT standard currently under development will provide a uniform interworking procedure to ensure that modems implementing a number of different standards can communicate.

For example, if a V.32 modem calls a V.22bis modem, the new interworking protocol provides a way for the V.32 modem to identify the receiving modem's standard and fall back to V.22bis mode to match it. While many modems are already capable of this, there is no standardized format to ensure that all modems do it in the same way. The new interworking standard should improve compatibility by increasing conformity. Expect the new interworking scheme to begin appearing in modems by 1991.

Another important standards issue that the CCITT expects to take up soon involves interworking between cellular modems and regular telephone-line modems. There is currently no accepted way to guarantee that these modems can communicate, but with the explosive growth of cellular technology and the increased mobility of laptop computers, this will become a major issue in a few years. Hopefully, the CCITT will finalize a standard to solve this problem soon. ■

Steven E. Turner is manager of technical staff research at UDS Motorola (Huntsville, AL), which manufacturers modems. He participates in several TIA and CCITT committees that develop modem standards. He can be reached on BIX c/o "editors."



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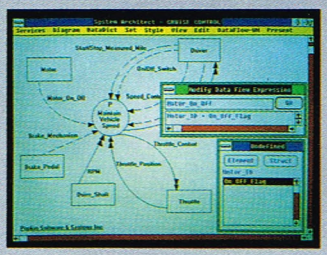
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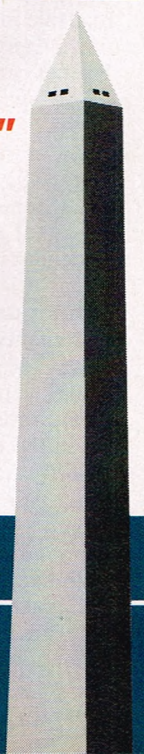
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PART 2

A KNOWLEDGE ENGINEERING TOOLKIT

Your own knowledge engineering toolkit for building expert systems

Marc Eisenstadt and Mike Brayshaw

As we discussed in last month's installment, there is a difference between knowledge engineering shells and toolkits. The shells are ready-made solutions and, as such, are restrictive. With this freely available toolkit, MIKE (which stands for Micro Interpreter for Knowledge Engineering), you can build your own solutions to knowledge engineering problems.

This month we continue with our account of the implementation and use of MIKE. For this discussion, it is important to keep in mind that the knowledge base is maintained in structured representations, called *frames*, that are rendered more readable in MIKE by declaring keywords and symbols such as `with`, `instance_of`, and the colon (`:`) to be infix operators. Frames can then be stored as ordinary database facts, as in the following:

```
fred_smith instance_of person with
 age: 40,
 citizenship: UK,
 weight: 160,
 occupations: [teacher, lifeguard, parent].
```

Inheritance

Inheritance is a recursive search along `instance_of` and `subclass_of` relations. Finding answers to queries frequently requires no more than a simple `fetch` of the appropriate database fact. For example, if we want to know Fred Smith's weight, given the representation presented earlier, we can find it out directly from the stored frame for Fred Smith because the slot:filler pair `weight : 160` is stored there. We explained in last month's section entitled "Frames as Database Facts" that the essential innards of the frame representation could be obtained with a query such as `?- fred_smith instance_of X with Y`, and that the variable `Y` would contain the relevant information. The crucial step, then, is to search along the conjunction of slot:filler pairs until a successful match is found. Failing that, another possibility is to look further up in the class hierarchy (e.g., under the frame for `person`) to see if an appropriate value can be "inherited."

When developing the code to carry out our intentions, we first define a "surface form" for the user's benefit, and an internal form that actually does the work. The surface form we would like you to use is as follows:

```
?- the weight of fred_smith is X.
```

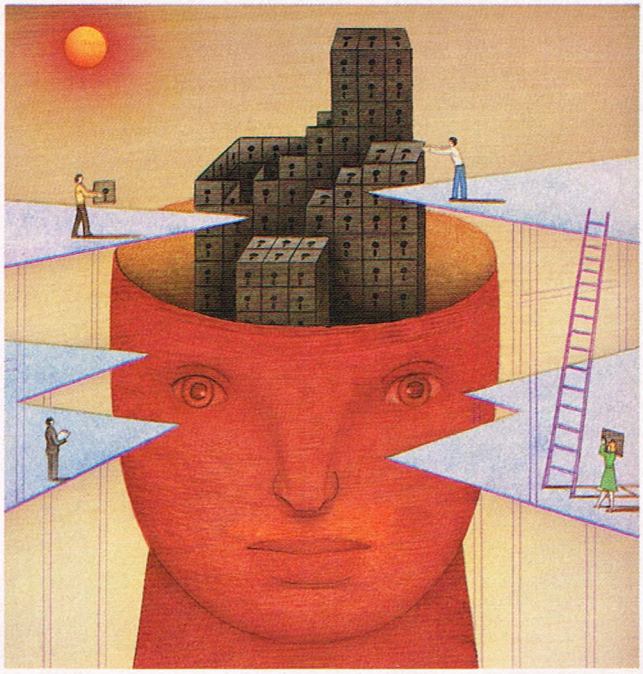
The relevant Prolog code is in listing 1, assuming our operators had already been defined as in last month's listings. The first clause converts the surface form into our internal form. The two clauses of `fetch` cater to the cases in which the object is stored either as an `instance_of` *something* or as a `subclass_of` *something*.

The real work is done by the clauses of `retrieve` and, in particular, by its final argument. The first clause of `retrieve` represents the case where the slot:filler pair `Attr:Val` (a) just happens to be the only slot:filler pair, (b) has a filler that is not a list (i.e., does not syntactically match the form `[_|_]`), and (c) is a successful match with the slot:filler pair we are searching for.

The second clause is similar, but in this case, the slot:filler pair `Attr:Val` is the very first pair in the (possibly long) conjunction of many. The third and fourth clauses are analogous to the first and second, but cater to the case when the filler is a list of values, such as `[teacher, lifeguard, parent]`, and it is therefore necessary to invoke `member` to see whether `Val` is a member of the list of `Vals`.

The fifth clause of `retrieve` optimistically tries to do more of the same, but this time matching against `Rest` (i.e., all but the very first of the slot:filler pairs). This is a standard cliché in Prolog, used for traversing lists or conjunctions of items.

The final clause of `retrieve` is reached only when the first five have failed. It invokes `fetch`, but this time passing in `Super` as the first argument to `fetch`, so that the searching ac-



tivity begins with the superordinate object in the class hierarchy (e.g., `person`, in the case of `fred_smith`). This provides for the cases when the slot:filler pair is not retrievable for a given object, so an attempt is made to retrieve the information further up the chain—this is essentially what "inheritance" means.

There are some important details that are omitted here, especially the problem of what to do when there is a conflict between "directly stored" slot:filler pairs and inherited slot:filler pairs. MIKE handles this correctly (e.g., the knowledge that "an ostrich cannot fly" overrides the knowledge that "birds can fly"), as illustrated in the commented MIKE source code. [Editor's note: *The Open University's MIKE source code and Expert Systems' Prolog interpreter are available in electronic format. See page 5 for details.*]

Backward Chaining in MIKE

MIKE's implementation of backward chaining is straightforward because it merely requires an invocation of the basic Prolog proof procedure. There are four main cases to deal with:

- Conjunction of goals (e.g., `'it is raining' & 'it is cold' & 'it is Tuesday'`). The technique is to invoke the `proof` procedure recursively on the first conjunct, and then on the remaining conjuncts.
- Frame access (e.g., `the age of john is 32`). The technique is to invoke the workhorse predicate `fetch`.
- Ordinary working-memory element (e.g., `'it is raining'`). Working-memory elements such as `'it is raining'` are stored internally using the predicate `wm`, so we just need to see whether `wm(`*`pattern`*`)` succeeds.
- Anything else. The technique is to try to find a stored rule whose conclusion matches the argument passed to `prove` and then recursively prove the premises of that rule.

These four cases map precisely onto the four clauses of `prove`, shown in listing 2.

Forward Chaining

Forward chaining searches for the first rule that has all its conditions already satisfied. It represents opportunistic processing (in contrast to goal-directed processing). The basic processing technique is to find any rule, all of whose left-side patterns (premises) are satisfied (i.e., in working memory), and then perform the associated RHS (right-hand-side) actions of that rule. The next thing is to do more forward chaining.

Successful termination occurs when the symbol `halt` is placed into working memory. The three clauses shown in listing 3 capture this processing concept concisely, with the final clause merely representing the terminating condition when no further suitable rules can be found.

As demonstrated in listing 4, a top-level goal `fc` (forward chain) ensures that working memory is cleared up prior to execution and places the special symbol `start` in working memory before invoking the workhorse `forward_chain`.

During forward chaining, a rule's left-side pattern is said to be satisfied either by being present in working memory or by being retrievable from frame memory. Working-memory elements are stored internally using the predicate `wm`, so in the most general case we just need to see whether `wm(`*`pattern`*`)` succeeds. More special cases exist for dealing with patterns such as `the X of Y is Z`. So the first four clauses of `in_mem` (listing 5) cater for these cases while the general case is left for last.

In a pure production system interpreter, the concept of performing RHS actions is restricted to adding or removing elements from working memory. In MIKE, we make this explicit with the operators `add` and `remove` and allow other special actions as well, such as `announce` and `halt`. The first clause of listing 6 handles conjunctions of RHS elements, while the second and third clauses deal with adding and removing working-memory elements, respectively. The fourth clause provides for cosmetic printout routines, and the final clause adds the special symbol `halt` to working memory for the benefit of the `forward_chain` workhorse routine.

Other cases of RHSes are dealt within the full implementa-

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Listing 1: *Fetching from the database. The first clause converts the surface form into our internal form. The two clauses of* `fetch` *cater to the cases in which the object is stored either as an* `instance_of` something *or when it is stored as a* `subclass_of` something.

```
the Attribute of Object is Value :-   % Surface form for user.
 fetch(Object, Attribute, Value).     % Our internal form.

fetch(Object, Attribute, Value) :-    % Here's its definition.
 (Object instance_of SuperObject      % Get stored frame.
     with Stuff),
 retrieve(Object, Attribute, Value,   % Invoke real workhorse.
     SuperObject, Stuff).

fetch(Object, Attribute, Value) :-    % Alternatively,
 (Object subclass_of Class            % stored frame might
     with Stuff),                     % be found here
 retrieve(Object, Attribute, Value,   % so invoke real
     Class, Stuff).                   % workhorse.

retrieve(Obj, Attr, Val, Super,       % Direct hit (single
     (Attr:Val)) :-                   % slot:filler).
 not(Val = [_ | _]).                  % Assumes singleton
                                      % value, not a list.

retrieve(Obj, Attr, Val, Super,       % Direct hit (first
     (Attr:Val, Rest)):-              % slot:filler pair of
                                      % many).
 not(Val = [_ | _]).                  % Assumes singleton
                                      % value, not a list.

retrieve(Obj, Attr, Val, Super,       % Single slot with
     (Attr:Vals)) :-                  % filler, which is a
                                      % list,
 member(Val, Vals).                   % so see that Val is on
                                      % list of Vals.

retrieve(Obj, Attr, Val, Super,       % First pair of many,
     (Attr:Vals, Rest)) :-            % filler is a list,
 member(Val, Vals).                   % so see that Val is
                                      % on list of Vals.

retrieve(Obj, Attr, Val, Super,       % Last arg is nasty
     (_:_, Rest)) :-                  % conjunct,
 retrieve(Obj, Attr, Val, Super,      % so traverse it,
     Rest).                           % searching for direct
                                      % hit.

retrieve(Obj, Attr, Val,              % Direct hits must have
     Super, _) :-                     % failed,
 fetch(Super, Attr, Val).             % so recursively check
                                      % out the superset!
```

Listing 2: *Examples of conjunction of goals, frame access, ordinary working-memory element, and conclusion of a rule.*

```
prove(First & Rest) :-                % Conjunction of goals,
 prove(First),                        % so prove the first
                                      % one,
 prove(Rest).                         % then prove the rest.

prove(the Attribute of Object         % Frame access,
     is Value) :-
 fetch(Object, Attribute, Value).     % so invoke frame-
                                      % access workhorse.

prove(Pattern) :-                     % A pattern is
                                      % 'satisfied'
 wm(Pattern).                         % if it is stored
                                      % in 'working memory.'

   prove(Conclusion) :-               % A conclusion can be
                                      % proved by retrieving
 (rule R backward if Premises         % a rule in which it
     then Conclusion),                % appears
 prove(Premises).                     % and then proving
                                      % that rule's premises.
```

Listing 3: *Forward chaining searches for the first rule, which has all its conditions already satisfied.*

```
forward_chain :-                      % Deliberate
                                      % termination occurs if
 wm(halt),                            % the symbol 'halt' is
                                      % added to working
                                      % memory,
 nl, write('Successful                % so inform user
     termination.'), nl.              % accordingly.

forward_chain :-
 (rule RuleName forward if LHS        % Find a rule,
     then RHS),                       % all of whose
                                      % left-side patterns
 all_in_mem(LHS),                     % are satisfied,
 not(already_did(RuleName,LHS)),      % and which we haven't
                                      % already performed,
 perform(RHS),                        % then perform
                                      % associated right-
                                      % hand-side actions.
 assert(already_did(RuleName,LHS)),   % Make a note to avoid
                                      % repeating this
                                      % exact case,
 forward_chain.                       % then carry on
                                      % forward-chaining.

forward_chain :-                      % This case only
                                      % reached when above
                                      % clause fails,
 nl,                                  % so inform user
 write('No (more) applicable rules.'),% accordingly.
 nl.
```

tion of MIKE, including those that let you perform arbitrary calls to Prolog code. But MIKE still needs to include a few bells and whistles.

The code given so far is sufficient to provide only the barest bones of a toy implementation of MIKE. We have presented the essence of the code to give you a feel for the basic concepts involved. In addition to providing numerous efficiency improvements (including protection against mindless backtracking), the full implementation has to deal with many conceptual extras, like true defaults, facets, conflict resolution, fast forward chaining, daemons, explanation facilities, and tracing.

True Defaults

Default reasoning means that we accept knowledge in the absence of information to the contrary. This requires an implementation of `fetch` that deals separately with instantiated and uninstantiated variables. In the example presented in last month's listing 1, you'll notice that the default `r_and_d_budgets of high_tech_consumer_market` are increasing (in the absence of information to the contrary). Nevertheless, the following query will erroneously succeed in the implementation just presented, even though the stored `r_and_d_budgets of home_computer_market` are actually decreasing:

```
?- the r_and_d_budgets of
   home_computer_market is increasing.
```

The query succeeds because, in the simplified implementation shown, it is possible to prove both cases (i.e., that `r_and_d_budgets` are decreasing and also that `r_and_d_budgets` are increasing). In the full implementation of MIKE, the above query correctly fails.

Facets

The implementation described above provides only for a simplified slot:filler notation, whereas the full implementation of MIKE allows a richer structure for fillers using fine-grained

Listing 4: *A top-level goal* `forward_chain`.

```
fc :-                                  % Top-level invocation.
 abolish(wm, 1),                       % Clear out working
                                       % memory.
 assert(wm(start)),                    % Add special 'start'
                                       % symbol.
 abolish (already_did, 2),
 forward_chain.                        % Invoke forward_chain
                                       % workhorse.
```

Listing 5: *Checking to see if a rule's left-side pattern is either in working memory or in frame memory.*

```
all_in_mem(First & Rest) :-            % Conjunction of
                                       % left-side patterns.
 in_mem(First),                        % See if the first one
                                       % is satisfied.
 all_in_mem(Rest).                     % Recursively see if
                                       % rest are satisfied.

all_in_mem(X) :-                       % Singleton pattern.
 not(X = (_ & _)),                     % This ensures that it
                                       % really is just a
                                       % singleton, not a
                                       % conjunction.
 in_mem(X).                            % See if it is stored
                                       % in working memory
                                       % or in frame memory.

in_mem(the Attr of Obj is Val) :-      % Patterns of this form
                                       % require frame access,
 fetch(Obj, Attr, Val).                % so invoke the
                                       % frame-retrieval
                                       % workhorse.

in_mem(X instance_of Y) :-             % This is useful for
                                       % looking up
                                       % instance_of
                                       % relations,
 (X instance_of Y with _ ).            % in which case we just
                                       % ignore the details
                                       % following 'with.'

in_mem(X subclass_of Y) :-             % This is useful for
                                       % looking up
                                       % subclass_of
                                       % relations,
 (X subclass_of Y with _)              % in which case we just
                                       % ignore the details
                                       % following 'with.'

in_mem(deduce X) :-                    % This is how we invoke
                                       % a backward-chaining
                                       % rule,
 prove(X).                             % in which case we let
                                       % the workhorse
                                       % do the work.

in_mem(X) :-                           % This is the usual
                                       % case, i.e., looking
                                       % for an arbitrary
                                       % pattern.
 wm(X).                                % Just see if it is in
                                       % the Prolog database
                                       % in this form.
```

attribute descriptors called *facets*. For example, consider the following frame for *dog*:

```
dog subclass_of animal with
  number_of_legs: 4,
  consumes: [dog_food, meat].
```

Here is the same frame using the richer facet notation:

```
dog subclass_of animal with
  number_of_legs:
```

Listing 6: *Additional RHS actions that MIKE provides for: conjunction of elements, adding elements, removing elements, cosmetic printout, and a trap for* `halt`.

```
perform(First & Rest) :-               % Conjunction of right-
                                       % hand-side patterns.
 perform(First),                       % Do the first one
                                       % (this will involve
                                       % one of the clauses
                                       % below),
 perform(Rest).                        % and then do the rest.

perform(add X) :-                      % MIKE operator 'add'
                                       % signifies 'add WM
                                       % pattern.'
 assert(wm(X)).                        % Invoke Prolog's
                                       % assert, which stores
                                       % pattern in database.

perform(remove X) :-                   % MIKE operator
                                       % 'remove' signifies
                                       % 'remove WM pattern.'
 retract(wm(X)).                       % Invoke Prolog's
                                       % retract, which erases
                                       % pattern from database.

perform(announce X) :-                 % Cosmetic printout,
                                       % e.g., announce
                                       % ['hi there,' X].
 writel(X).                            % Invoke user-defined
                                       % Prolog utility to
                                       % perform printout.

perform(halt) :-                       % Special trap for
                                       % 'halt' action.
 assert(wm(halt)).                     % Just add pattern for
                                       % forward_chain
                                       % to notice.
```

```
[value: 4,
type: integer,
cardinality: 1,
inheritance: supersede],
consumes:
[value: [dog_food, meat],
inheritance: merge].
```

The `value` facet specifies what the actual filler is, whereas the `type` facet specifies a run-time restriction that traps anomalous assertions applied to subclasses or instances of the class `dog`, as the following interaction illustrates (assume we have already stored `fido instance_of dog`):

```
?- note the number_of_legs of
fido is mumble.
Warning: 'mumble' violates the
'type' facet of 'dog' for
slot 'number_of_legs',
which specifies type: 'integer'.
```

The `cardinality` facet specifies how many values are allowed to fill the slot. The `inheritance` facet allows the user to distinguish between values that supersede inherited values (e.g., `?- note the number_of_legs of fido is 3` would supersede dog's 4 legs) and those that merge with (i.e., augment) inherited values.

Consequently, the `inheritance:merge` specification for slot `consumes` of class `dog` allows the inference that dogs consume not only `dog_food` and `meat`, but also whatever is in the `consumes` slot of class `animal`. In the full implementation of MIKE, both simple slot:filler and complex slot:[facet:filler] notations are allowed.

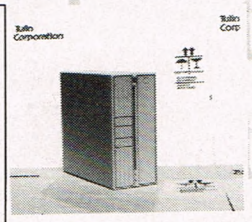
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MIKE

incorporates three conflict-resolution strategies and allows the user to select combinations from among these, or even to add more.

Conflict Resolution

The definition of `forward_chain` presented here so far doesn't specify what to do if several rules have all their left-side patterns satisfied; in that event, it will choose the first one. But a true conflict-resolution strategy requires a *principled* selection of a winner.

MIKE incorporates three conflict-resolution strategies and allows the user to select combinations from among these, or even to add more. The supplied strategies are:

- *refractoriness*, which prevents identical rule instantiations from firing multiple times,
- *recency*, which prefers rules that apply to the most recently added working-memory elements, and
- *specificity*, which prefers rules that have a greater number of conditions on their left sides.

The simple implementation presented above simulates refractoriness by means of the database flag `already_did (RuleName,LHS)`.

Fast Forward Chaining

The definition of `forward_chain` embodies a very naive algorithm (i.e., "Find some rule and test whether all its left-side conditions are satisfied") and incurs huge overheads when the set of rules is large. Fast indexing algorithms (e.g., RETE and TREAT) ensure that the only rules that ever get considered are those whose left-side conditions involve recently modified working-memory patterns. Future releases of MIKE will incorporate such an algorithm.

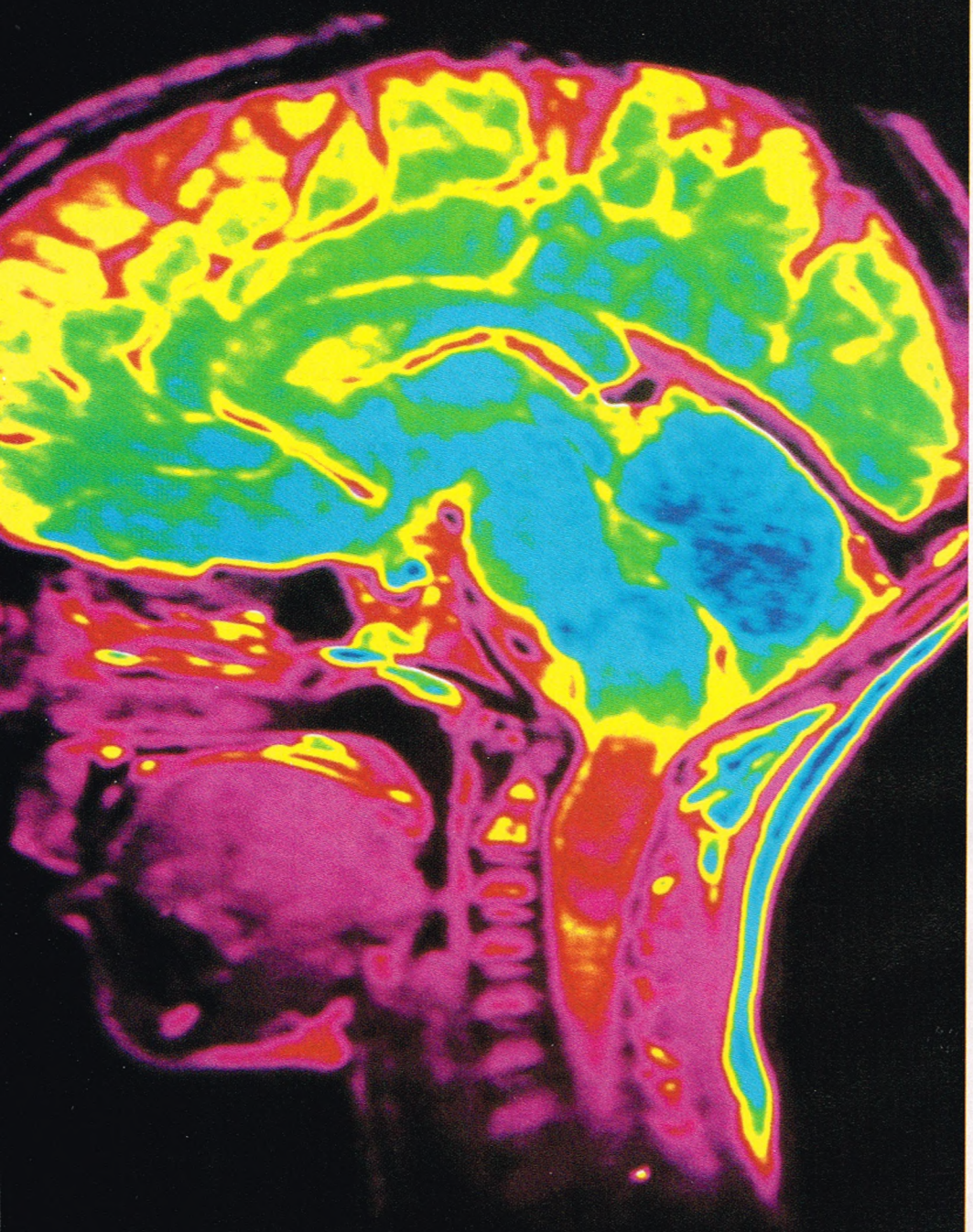
Daemons

Actions associated directly with specific slots in a frame object can be invoked either when slots are accessed or when slots are changed. In MIKE, these are specified by extra facets called `access_rule` and `change_rule`. They use the same syntax as MIKE's rule notation. For example, here is an `access_rule` daemon that calculates (at run time) the volume of any instance of class `vessel`:

```
vessel subclass_of object with
  volume:
  [value: unknown,

  access_rule:
  (if
  the height of ?self is H &
  the width of ?self is W &
  the depth of ?self is D &
  prolog(Vol is H*W*D)
```

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Listing 7: *Rule graph for a sample interpreter run.*

```
 RULE NAME                        CYCLE NUMBER(1-13)
                                       ....:....1...
initialization_rule                   *++++++++++++
boilingWater_UnplugKettle              *  +++++++++
boilingWater_FillKettle                 *
boilingWater_PlugInKettle                *
boilingWater_SwitchOn                     *++++++++
boilingWater_WaterBoiled                   *+++++++
makingTea_AddTeabag                       +++++*++++++
makingTea_AddBoilingWater                       *++
makingTea_BrewingTea                             *+
makingTea_RemoveTeaBag                            *
makingTea_MilkAndSugar                             *++
makingTea_MilkRequired                              +++
makingTea_SugarRequired                             +++
makingTea_StirringMilkAndSugar                       *+
makingTea_StirringMilk                               ++
makingTea_StirringSugar                              ++
makingTea_StirringTea                               +++
makingTea_TeaIsMade                                  *
```

ITEMS DISCUSSED

MIKE
Part of a text/video package "Knowledge Engineering" (#PD624). Comes with a Prolog interpreter for MS-DOS.
The Open University
Learning Material
Sales Office
P.O. Box 188
Milton Keynes MK7 6DD
U.K.
44-908-653338
Inquiry 1016.

Prolog Interpreter
Supplied with MIKE; a version of Prolog-2.
Expert Systems, Ltd.
Unit 12, 7 West Way
Oxford OX2 0RD
U.K.
44-865-794474
Inquiry 1017.

```
  then
  the volume of ?self is Vol)].
```

Now, suppose you have the following instance of `vessel` defined:

```
tank1 instance_of vessel with
  height: 10,
  width: 10,
  depth: 10.
```

The next interaction shows the effect of invoking the `access_rule` daemon:

```
?- the volume of tank1 is What.
What = 1000.
```

Explanation Facilities

During execution, it is useful to be able to pose "how" and "why" queries that specify, in a comprehensible format, how particular conclusions are justified and why a particular question is being asked. This capability is included in the full implementation of MIKE.

Tracing

Monitoring the details of rule execution is critical for debugging purposes. MIKE provides both coarse-grained and fine-grained views of the execution process to facilitate debugging.

The special command `?- show history` produces a display of the behavior of each rule at each cycle of execution during forward chaining. The style of the graph is based on TRI (Transparent Rule Interpreter), a powerful "click, point, and zoom" rule-tracing environment implemented on a Symbolics AI workstation by our colleague, John Domingue.

In the example in listing 7, cycle numbers are shown along the top row (with a "." for each cycle, a ":" for every fifth cycle, and an integer for every tenth cycle). The left side of the display shows the name of each rule. The symbols in the table indicate the fate of each rule on each cycle. A "+" symbol means that the rule entered the conflict set (i.e., it was a potential candidate), but it was not actually fired. A "*" symbol means that the rule not only entered the conflict set, but was also the one selected for firing. Listing 7 is a sample history trace showing a simple forward-chaining rule base designed to make a cup of tea.

The Value of MIKE

MIKE forms the backbone of an Open University Study Pack on Knowledge Engineering, which includes text and video material that is centered around case studies of knowledge-elicitation exercises, and a review of commercial knowledge engineering toolkits.

MIKE fulfills three purposes in the context of the Open University's Knowledge Engineering course:

- It provides a "paper and pencil" surface syntax that helps to concretize discussions about different styles of knowledge representation;
- It provides a working implementation that encourages user experimentation via numerous hands-on exercises; and
- It provides fully commented source code that illustrates how to implement a knowledge engineering environment from scratch.

In the interest of portability, a conservative subset of "Edinburgh-syntax" Prolog was used to develop MIKE, and graphics were completely avoided. Even the tracing facilities are essentially "glass teletype." This may seem somewhat surprising, given our own commitment to state-of-the-art environments for both knowledge engineering and graphical rule tracing in Prolog. However, we thought it preferable to adopt a least-common-denominator strategy to encourage the most widespread dissemination of our courseware. We are encouraging users to modify MIKE software and to give us suggestions and improvements for incorporation into future iterations.

An important motive of this whole exercise has been mass consciousness-raising. MIKE contributes to the dissemination of knowledge engineering techniques, and the design and implementation of knowledge engineering environments. ■

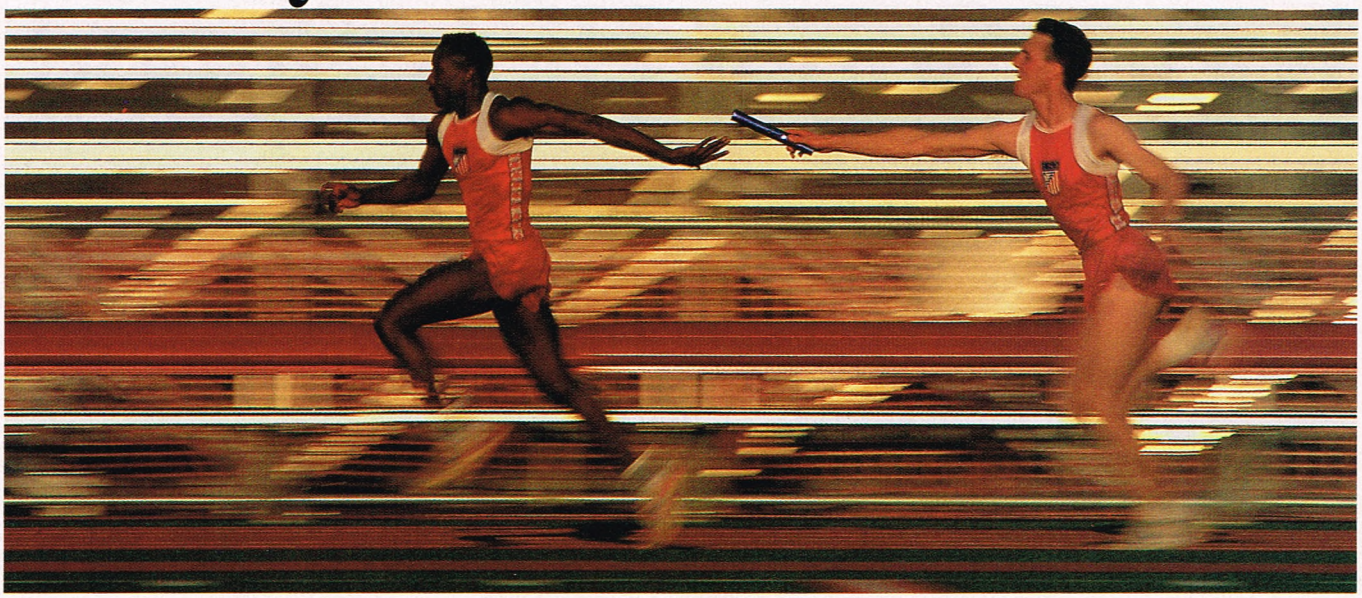
ACKNOWLEDGMENT

The software described in this article was designed and developed under the auspices of a grant from the U.K. Science and Engineering Research Council. The "rule graph" notation was directly inspired by the work of our colleague, John Domingue.

Marc Eisenstadt is a professor of AI. Mike Brayshaw is a Research Fellow. Both authors work at the Human Cognition Research Laboratory at the Open University in England, where they are currently focusing on program visualization and the Prolog programming language. They can be reached at the Open University or on BIX c/o "editors."

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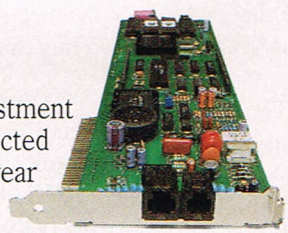
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HOT LINKS TO GO

Dynamic Data Exchange lets Windows and OS/2 applications share data easily

Michael Vose

Windows 3.0 and OS/2 Presentation Manager (PM) endow application programs with a common look and feel. Programs running simultaneously almost seem to blend together. When they employ a service called Dynamic Data Exchange, they functionally do. With DDE, a program can use another program's data as though it were its own. This intimate sharing of information promises to integrate tomorrow's programs as never before.

While graphical user interfaces (GUIs) abound these days, DDE sets Windows and PM apart from the rest. I'll look at how DDE works and describe how you can use it to realize a new level of interprogram harmony.

The Information Melting Pot

Both Windows and PM can multitask different applications, as well as instances of the same application (sharing code across instances). PM applications can also multitask internally—a program might dedicate one thread to menu handling and another to screen updating. Furthermore, with the multiple-document interface, a Windows or PM application can maintain several active documents. All this concurrent activity, along with a common look and feel across programs, encourages users to view the system as a whole and to expect the parts—including data—to work together.

Getting information from one program to another has always been a thorny problem. In the character-based world of DOS, nearly every application specifies its own unique format for storing and displaying information. To exchange information, you have to negotiate some sort of format conversion.

GUIs and some character-based windowing systems try to overcome this problem with cutting and pasting. Although well understood and useful, cutting and pasting suffers from several limitations. It involves several steps: You have to select the information, cut or copy it, indicate a destination, and then paste the information. Cutting and pasting can limit you to text- or character-only information exchanges. Additional information (in the case of text, fonts and emphasis) often doesn't survive the transfer. Most important, information exchanged by cutting and pasting is static; if the original information changes, you have to redo the data exchange.

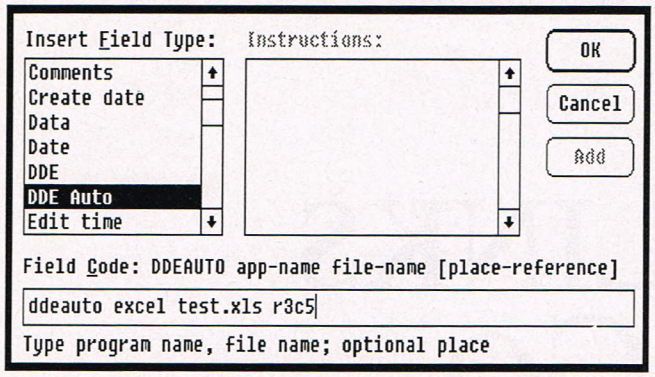
DDE addresses these information-exchange inadequacies. As its name implies, DDE enables programs to share information even as the information changes. In addition, DDE operates automatically once a user connects one or more applications.

The programming team that wrote Microsoft Excel invented DDE to show how to use Windows' message-based interprocess-communications facilities. Windows incorporated DDE in version 2.0; PM had it from the start. (A special dynamic link library to implement DDE under Windows 1.0 appeared just before Windows 2.0 was released.) DDE extends the message-based architecture of Windows and PM. Developers can incorporate DDE, which is a documented protocol for interprocess communication, into any Windows or PM program. Such programs can then exchange information whenever instructed to do so.

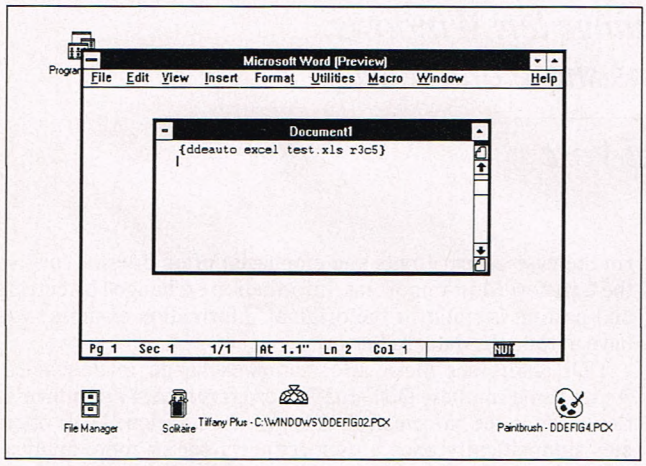
DDE's Many Uses

Although DDE has been around for some time, not many programs use it yet. The programs that do support DDE illustrate a variety of information-exchange scenarios:

- *Stock reports with hot links to real-time data.* With a telecommunications hookup to a stock-reporting service like Lotus Signal (which uses an FM radio sideband to transmit stock data), a DDE-capable spreadsheet receives data from a stock-tracking program, records every change in the price of one or more stocks, and recalculates the value of a portfolio.
- *On-line airline reservations.* A network of PCs links a reservation database to a graphics program showing an up-to-date diagram of the available seats on any scheduled flight. This application uses a background "redirector" that intercepts DDE traffic, converts it to the appropriate network protocol, and



Screen 1: *This is the Word edit box for creating a field in a document. This example creates a DDE field that links a cell in an Excel spreadsheet to a Word document.*



Screen 2: *In this Word document, the DDE field displays the DDE application topic and item names. Alternatively, it could show the value of the referenced spreadsheet cell.*

sends it across the network to another station where a similar redirector converts it back to DDE.

• *Compound documents.* These are DDE-linked word processing elements that each manipulate a separate document but share some common text with each other and are thereby always up-to-date—even if the individual documents are on different machines on a network.

• *Data queries across applications.* A spreadsheet queries a database for information that updates itself whenever the database changes. The PM version of AutoCAD uses this kind of DDE link to let an Excel spreadsheet's materials worksheet control an AutoCAD drawing.

• *Links to remote mainframes.* DDE-capable communication programs link mainframe databases to PC-based spreadsheets or word processing programs.

• *Remote data gathering.* Using data acquisition hardware, a DDE-based software module collects data and simultaneously saves it to disk, links it to a chart program that diagrams the incoming data, and also links it to a spreadsheet that computes averages.

• *Downloads from E-mail or communications services.* Instead of reading information on-line, a DDE-based telecommunications program saves messages to disk or places them into a word processor document for later perusal.

In each case, automatic transfer of data between applications frees users from mundane and repetitive cutting and pasting and welds individual programs together to create metaprograms that are more than the sum of their parts.

On the Links

DDE supports both temporary and permanent information exchanges. Temporary exchanges are simple transactions. A program requests information and receives it or sends information and receives an acknowledgment. Permanent exchanges come in two varieties: hot and warm. When sender and receiver communicate by way of a DDE "hot link," information flows only when the sender has new data to transmit. In the case of a "warm link," the sender tells the receiver that there's new data, but doesn't send it until the receiver asks for it.

A program's user establishes temporary or permanent links between applications. In a DDE spreadsheet like Excel, for example, you do that by placing a formula into a worksheet cell. This formula describes the target application and the nature of the link. For example, to link an Excel spreadsheet to the Quotes stock market reporting program, you place a formula into a cell as follows:

```
= 'QUOTE' | 'NYSE' ! IBM
```

This formula contains the three essential pieces of DDE syntax: application, topic, and item names.

In Microsoft Word, DDE links are fields. Along with time, date, and comment fields, Word also supports a DDE field. To link a Word document to an Excel spreadsheet, you specify the DDE names. The edit box in screen 1 gives an example. Following the field code DDEAUTO there is the target application's name (`excel`), the topic name (`test.xls`, a data file), and the item name (`r3c5`, the cell that has the information).

Once established, this link will place whatever value resides in that worksheet cell into the Word document and will change it automatically if the worksheet value changes. The Word document can either display the value or, as screen 2 illustrates, show the field specification that governs the value. As you can see, it takes just a few steps to link programs together. You can terminate a link just as easily.

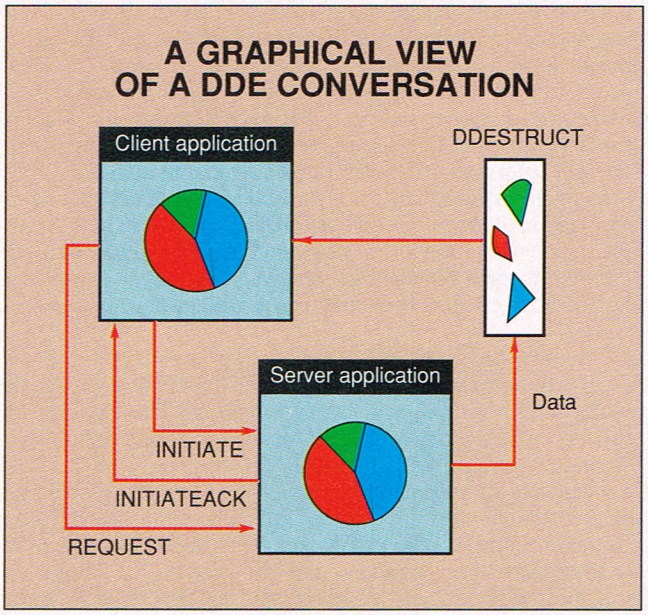
Links between programs can refer to fields within files, or to entire files. File-level links ensure that changes to a master file propagate to any files linked to that master. These secondary files need to be open to stay in sync with the original.

Users of programs that support DDE don't generally need to worry about whether they're running under Windows or PM. Most programs that support the two environments forge DDE links the same way. Internally, as you'll see, Windows and PM handle DDE a bit differently.

How DDE Works

The underlying mechanisms that make DDE possible depend on the message-based architecture of Windows and PM. Under these environments, when anything happens—a mouse-click, key press, window-dragging operation, or menu selection—the operating system broadcasts a message. These messages accumulate in either a system message queue or an application message queue. Within every Windows or PM application, a message loop continually examines these messages, selects those that it needs to handle, and ignores the rest.

Windows' cooperative style of multitasking relies on the messaging system. Whenever any application retrieves a message from the system message queue and acts on it, Windows gives that application control of the CPU. Before it can check



In a typical DDE conversation, the client initiates the conversation, and the server acknowledges. The client then requests data, which the server puts in shared memory.

the message queue again, all other running programs get a crack at the queue and a chance to gain control. Although PM structures the retrieval and processing of messages in a similar way, OS/2 handles multitasking differently. A scheduler in the operating-system kernel parcels out CPU time to program threads.

The stream of messages flowing within Windows and PM enables DDE. It is simply a message protocol: the definition of a series of messages that Windows and PM programs can respond to and act on.

The Client-Server Model and Conversations

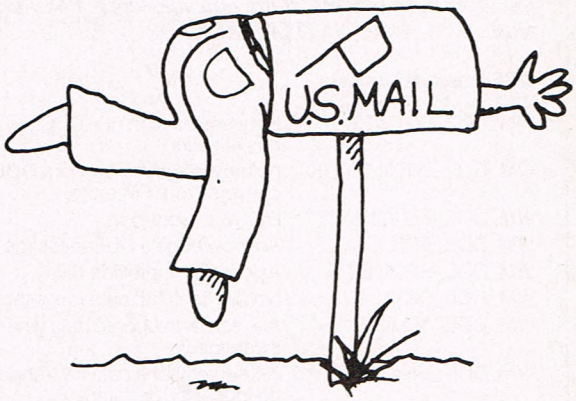
The *client-server model* and the *conversation* are the two key conceptual ingredients of DDE. With the client-server model, a DDE server provides data, and a DDE client consumes it. This apparently simple model can get complicated, however, because a client can have multiple servers, and a single program can function as both a client and a server. These complex scenarios are particularly likely under multitasking systems. For example, one application can receive data from a second as a client and then act as a server to pass information along to a third. Applications can simultaneously play the role of both client and server (in two separate conversations) to simulate a two-way peer-to-peer interaction.

The interactions between a DDE client and server are called conversations. Conversations between programs work like telephone conversations between people. One program initiates a conversation, the other acknowledges that a conversation has begun (like soneone answering a phone), information flows, and, finally, one program terminates the conversation.

Conversations from a client program not only target a server application but also specify a topic and an item. A topic is typically a filename, and an item is any specific data object—usually specified by a field, cell, or range—within that file. Each data object requires a separate request.

The behind-the-scenes logic of a DDE conversation goes like this (see the figure): The client starts a conversation by sending

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DDE MESSAGES

The DDE message sets for Windows and Presentation Manager. The two sets share nine messages. PM adds a tenth: WM_DDE_INITIATEACK.

DDE Message	Purpose
WM_DDE_INITIATE	Request the start of a DDE conversation.
WM_DDE_INITIATEACK	Acknowledge the start of a DDE conversation (PM only).
WM_DDE_TERMINATE	Halt a conversation.
WM_DDE_ACK	Acknowledge a DDE message.
WM_DDE_REQUEST	Ask server to provide data.
WM_DDE_DATA	Notify client that data is available.
WM_DDE_ADVISE	Ask server to update data whenever it changes.
WM_DDE_UNADVISE	Tell server that a data item should no longer be updated.
WM_DDE_POKE	Ask server to accept unsolicited data.
WM_DDE_EXECUTE	Sends a command string to server.

Listing 1: *API calls to initiate a DDE conversation under Windows and PM.*

Windows

```
SendMessage(
    (HWND) -1,
    WM_DDE_INITIATE,
    hMyWnd,
    MAKELONG(aApp, aTopic)
    );
```

Presentation Manager

```
WinDdeInitiate(hwnd, "AppName", "TopicName");
```

Listing 2: *Presentation Manager DDEINIT and DDESTRUCT data structures. The DDEINIT structure holds the application and topic names (Windows stores these in atoms). DDESTRUCT holds the name of the item, its format, and the item's data.*

```
typedef struct_DDESTRUCT {
   ULONG      cbdata;
   USHORT     fsStatus;
   USHORT     usFormat;
   USHORT     offszItemName;
   USHORT     offabData;
}  DDESTRUCT;

typedef struct_DDEINIT {
   USHORT     cb;
   PSZ        pszAppName;
   PSZ        pszTopic;
}  DDEINIT;
```

out a DDE-initiation message. The target server application (or any interested application if the client names no specific target) responds with an initiation-acknowledged message. The client program next sends a message containing a topic and an item name, and it requests either a permanent or temporary information exchange. The server then responds by sending the requested information. A client application can also send unrequested information to a server and can instruct the server application to execute one of its internal commands. For example, under Windows 3.0, a program's installation module can tell the Program Manager to create a group and add an item to it. Either the client or the server can terminate the conversation.

DDE Nuts and Bolts

DDE relies on a series of nine messages (10 under PM—see the table) and several important data structures. These data structures provide a memory format for the information that flows during a conversation. The DDEINIT and DDESTRUCT PM data structures appear in listing 2. Windows uses global data structures that programs create with calls to the `GlobalAlloc` function. Parameters accompanying each DDE message point to these structures. Windows and PM store the DDE information itself (e.g., spreadsheet values and text) in memory that the client and server share. The client application program must allocate memory for all DDE data structures when it initiates a DDE conversation.

A DDE conversation begins when a client broadcasts a WM_DDE_INITIATE message. Under Windows, you use the generic application programming interface function `SendMessage`; under PM, there's a special `WinDdeInitiate` call (see listing 1). Similarly, Windows uses `SendMessage` and `PostMessage` API calls for sending subsequent DDE messages, while PM uses a special call, `WinDdePostMsg`.

Once a DDE conversation has begun, a client application conducts an exchange by performing the following actions:

- *Allocate memory for the DDE memory object.* This action creates the shared memory area that both applications will use.
- *Create a format for the information to be exchanged.* Windows and PM provide a predefined format (clipboard format) for exchanging string data. A program must create its own format for exchanging other data, like graphics.
- *Select an information-exchange type.* The client program specifies whether an exchange will be one-time-only, a hot link, or a warm link.
- *Send a DDE message.*
- *Deallocate DDE shared memory.* This step cleans up memory after the completion of a DDE.

Each DDE conversation requires a separate window on both ends. It might be a main application window, a window associated with a specific document, or a hidden window that never appears on the screen.

Differences Between Windows and PM DDE

Although their DDE message sets are nearly identical, Windows and PM use slightly different schemes for passing information among applications. This difference results from a key distinction between the memory-addressing design of their respective underlying operating systems.

Windows DDE uses 16-bit handles to global memory objects to locate exchangeable data. PM limits access to global memory and instead uses a 32-bit memory selector to pass data between OS/2 processes.

There are two parameters available as arguments for any

given DDE message. The first designates the handle of the target window. A second 32-bit parameter contains all other conversation particulars, including memory selectors. The designers of PM foresaw that this parameter could not forever accommodate the ever-increasing size of processor address spaces and LAN communications needs, along with strings to identify DDE objects. So, under PM, the second parameter of DDE messages became a pointer to one of two DDE data structures. These structures contain all the necessary DDE conversation parameters, as well as the actual data being exchanged. This scheme ensures that PM can accommodate future system software changes and new hardware architectures without altering the DDE message format.

Windows uses atoms (i.e., integers that identify character strings) to refer to the information being passed between a client and a server, and global memory handles to refer to the data structures that actually contain the data. These atoms and handles form the contents of the second parameter sent with every DDE message (the first being the target window handles). PM uses a separate DDE data structure (pointed to by the second DDE message parameter) in which to package conversation parameters and data. This makes using atoms unnecessary.

Because of the restrictions that OS/2 places on a process when it attempts to access another process, PM uses a special set of DDE API calls that grant this access automatically. These special calls include `WinDdeInitiate`, `WinDdeRespond`, and `WinDdePostMsg`.

DDE and the Integrated Desktop

Multitasking and DDE will increasingly display a symbiosis within the next generation of PC applications. Multitasking provides for the functional integration of applications, and DDE furnishes the concordance of information. Once they discover that they can connect disparate applications seamlessly, users will stop thinking about tools (applications) and start focusing on specific documents or tasks. Windows 3.0 and PM both provide a way to group tasks according to the needs of any user. The ability to group all the documents needed to produce a firm's annual report, for example, helps the person working on the report focus on the pieces of the project rather than on the tools used to complete it.

Grouped tasks lead to the organization of computer desktops into workspaces—a workspace for the annual report, a workspace for the new building proposal, and so on. Within each workspace, many applications and documents will be open; some of these will share information via DDE links.

DDE extends an application by enabling it to use information from another program that it otherwise could not generate itself. For example, when you use DDE to embed a chart from a program like Microsoft PowerPoint into a word processing document, you add to the word processing program a capability that it otherwise would not have.

Because DDE preserves the format of exchanged information, it eliminates such problems as having to alter the font or point size of data linked from an Excel spreadsheet to a Word document: DDE can send font and size information with the data. This preservation of format further enforces the idea that pieces of information are objects that users can mix and match.

With all these benefits and possibilities, you can bet that DDE is a term you will be hearing about much more frequently in the not-too-distant future. ■

Michael Vose is the author of the book Windows 3.0: A Definitive Guide for DOS Users *(Addison-Wesley, 1990). He can be reached on BIX c/o "editors."*

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■ Mac Exchange Update

This month we'll continue our group project on making a Mac-like front end program for BIXing. Both users and coders are contributing some excellent ideas. You'll definitely want to get in on the action. (join mac.hack/general)

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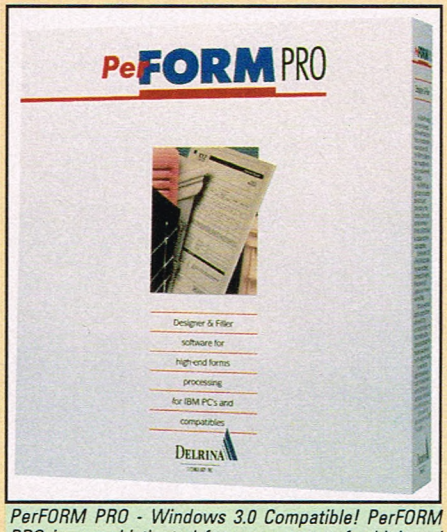


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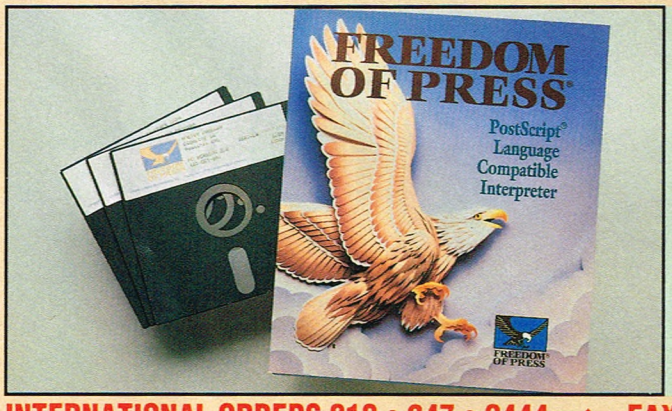
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PICK: OS OR DBMS?

An ancient breeze still blows through the database world

Ben Smith

PART Four

Pick: It's an operating system; it's a database system. It's both. Although Pick is most often found as a stand-alone operating system, you may see it implemented as a database engine working under other multiuser operating systems, such as Unix. Databases have their own special needs for optimal data storage and retrieval. Pick meets those needs and provides the data organization that makes for efficient database operations.

Prehistoric Synergism

Many computers are used for the single purpose of database operations. In this case, Pick is all you need. It includes all the layers and activities of an operating system: everything from virtual memory management, terminal control, and print spooling and control up through multiuser task, account, and file management, as well as a command interpreter and scripting language. Pick also includes all the tools for database operations: programs to structure the data, a language for data entry and data manipulation, and a report formatter.

Pick is more than a collection of utilities and libraries; it is a completely integrated operating system/database engine—greater than the sum of its parts. There is nothing new about this idea, but that may be because Pick is far from new. Richard A. Pick and his colleagues at TRW started development on the IBM System/360 in 1965. That makes Pick older than CP/M (1977) and even Unix (1970).

Pick's organization of data helped it survive all those years and through all the changes in the computer industry. The entire system is consistently built using the same data structure: a tree of data dictionaries and data files, usually paired together. Even the Pick commands are held in this structure. As a result, nearly everything in Pick *is* a database and can be manipulated any way you like.

From the average user's point of view, the operating system and database operations (e.g., input, search, and report) are simple and fast. But the developer must come to Pick with as few preconceptions as possible. Developing Pick applications is unlike working in any modern development environment.

At first glance, Pick appears to be hopelessly atavistic. The environment consists of a primitive, uppercase-only command interpreter, a special-purpose line editor, and a steroid-mutated BASIC. If you are used to fancy window- and menu-based data management tools, Pick will seem rough and unfriendly. But under this crude surface, there are many fine ideas, implemented in a refined (though Spartan) manner.

Operating-System Sorts of Things

Pick's multitasking (and multiuser) capabilities are bare bones. The operating system maintains separate user log-in accounts, each with its own *master dictionary*, a file that holds pointers to all of the account's files and commands.

Accounts are linked more closely with the data they hold than with the people who use them. Everyone using an inventory-control database, for example, would likely share an account. The system has commands for managing these accounts, handling system backups and restores, and monitoring system use. There are utilities for transferring files to and from MS-DOS partitions that might coexist with the Pick partitions on a PC.

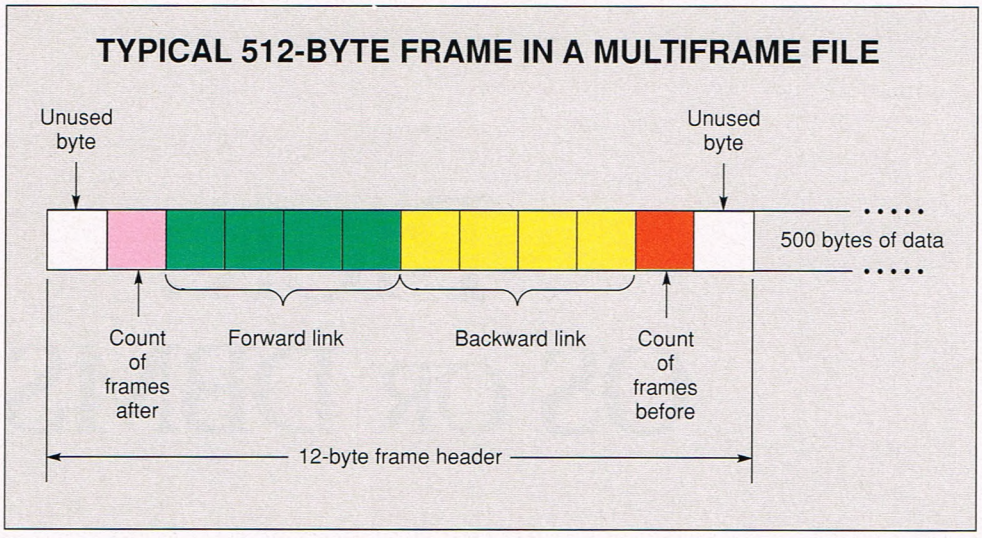
Installation of external terminals and printers is easy on a Pick system. There is one file describing terminal capabilities, another to configure serial ports, and another that describes the parallel printer ports.

A user can have more than one task running at a time (in

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A frame is the basic Pick unit of memory; different implementations of Pick use different frame sizes. On the PC, frames for executables and workspace are 2048 bytes, while frames for files (shown here) are 512 bytes. Frames are linked together through a pair of pointers at the front of each block.



addition to print spooling). Such tasks are called *phantom processes*. They handle administrative duties while users are busy with applications. But there isn't any path to client/server connections on a single machine; there are no interprocess communications links other than semaphores. However, different Pick machines *can* communicate with each other; even MS-DOS can communicate with Pick.

Virtual Memory

The Pick operating system addresses both memory and disk as a single mass. This mass is divided into a file area at the high addresses, and executable and work areas at the low addresses.

A *frame* is the basic Pick unit of memory. Each frame is referenced by a unique frame identifier. Different implementations of Pick use different frame sizes.

On the PC, there are two sizes of frames. Frames for the executables and workspace are 2048 bytes in size and are not linked. Frames for files take 512 bytes and often form doubly linked lists using 12 bytes (of the 512) of data to create the connections (see the figure). Alternatively, file space can be allocated in blocks of contiguous frames, in which case the block does not require the 12 bytes per frame for memory management; all 512 bytes is available in each contiguous frame.

The virtual memory manager, which tracks the location of data, works directly with the hard disk and RAM. This invisible layer of device control is responsible for Pick's efficiency on otherwise inefficient or obsolete computers.

The Database

The data files and associated dictionaries allow you to build a complex interrelationship between data files, since a data item in one file can be a pointer to data in another file. This kind of structure is more akin to a hierarchical data structure than the relational structure that is common on microcomputer databases. Most relational database systems have fixed-length data fields, but Pick data fields are held in a variable-length format. As you will see, this is a very important feature.

Both of the data pair (dictionary and data) files have the same structure. The dictionary contains the definitions of fields (*attributes*, in Pick terminology) in the data file, and pointers to the fields that use the defined structure. Not only can each attribute within a record (or *item*) contain a value, but each value can be composed of subvalues. Each item within a file must have a unique (to the file) *item-ID* with which Pick manages its data operations. The item-ID may actually be data itself—for example, a part number.

With this structure, an attribute value (or subvalue) may be the item-ID of another file, or even of the same file. This last capability solves the vexing database problem of how to organize data so that items can be assemblies of peer items. For

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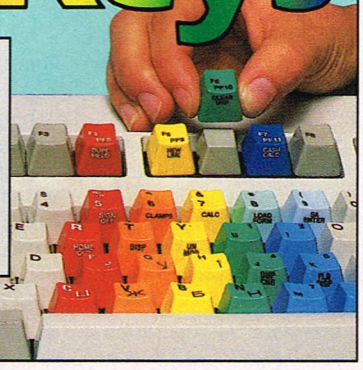
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example, a parts-numbering scheme usually has unique numbers for both assemblies and the items included in the assemblies. Some of the assemblies may also contain subassemblies. Since the items can vary in length, each item can have a different substructure. Some items may list other items or subassemblies, and some items may just be elements in themselves.

Other Strengths and Weaknesses

Since Pick is a multiuser database/operating system, it necessarily includes a form of record locking to prevent collisions of data operations on the same sets of data. There is also a very limited form of process locking. As more than one user can run the same program at the same time, the PROC scripting language contains a semaphore for control between concurrent users. But the semaphores are local to each PROC script and so do not offer any way for different programs to communicate.

The way data is written and read is a weakness. Pick searches data using the unique item-IDs of a file, but the search is sequential since there is no index. On the plus side, the overhead and restrictions imposed by maintaining an index don't exist. You can create any kind of index with a data file; the recursive structure of a data tree is already there.

A strength comes from the variable-length data items in a file: A file can actually be a single piece of text, a script, or a Pick BASIC program. Like dictionary files, these file forms don't have a structure defined elsewhere.

New Era

Pick has been around a long time. Respect, as well as many applications, has accrued over the years. Word processors, spreadsheets, and other typical business fare are available. Most important, there are thousands of proven vertical applications that run on hundreds of different species of computers.

Recent months have marked the beginning of a new era for Pick with the introduction of Advanced Pick and Pick running under Unix. Advanced Pick is backward-compatible with the original, but this crispy version includes many features that will attract modern applications developers: a screen editor, secondary indexing and B-trees, transaction logging (necessary for good computer-based accounting systems), and new utilities for developing screens and tuning an organization of data without resorting to Pick BASIC.

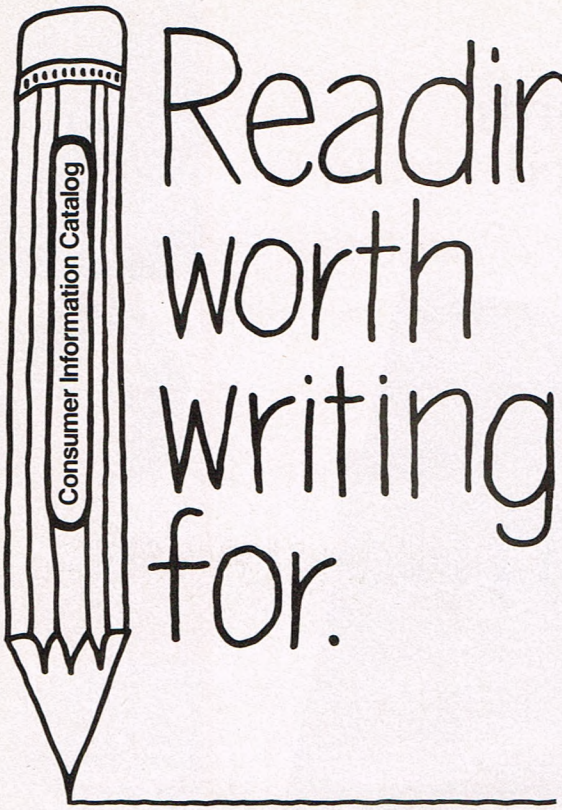
Pick under Unix fulfills needs in both computing realms: Unix gains an efficient database engine; Pick gains the connectivity and utility of Unix. Because the Unix file system was not designed with database operations in mind, you need a separate database file system for Pick. Turbo Informix, another popular Unix database manager, uses a similar method to improve its performance. But the integration of Pick and Unix goes beyond coexistence; Pick can call Unix functions, and Unix can call Pick functions. Data flows freely between the two.

Pick's strength is not as an operating system (it is outdated technology), but in its flexibility and efficiency in handling data. For this reason, Pick not only will survive, but will flourish as a database engine implemented under other, more capable operating systems. ■

ACKNOWLEDGMENT

Many thanks to Tim Thomas of Mini Business Systems, Inc. (Southbury, CT), for being a source of Pick technical information and enthusiasm.

Ben Smith is a technical editor for BYTE and the author of the book Unix Step-by-Step *(Howard Sams, 1990). He can be reached on BIX as "bensmith."*



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MODULA-3

A practical and predictable OOP language for team projects

Sam Harbison

If you are a Pascal or Modula-2 programmer, you may have found yourself choking in the dust behind the stampede to C++. Choke no longer. Modula-3 has arrived.

Modula-3 is not an extension to Modula-2, but a new language in the spirit of Pascal and Modula-2. It combines the best features of a modular, strongly typed language with support for object-oriented programming (OOP), exceptions, and concurrency. As a result, Modula-3 is an effective tool for building large, maintainable, robust systems.

Roots

Modula-3 was developed by researchers at Digital Equipment's Systems Research Center and the Olivetti Research Center. It borrows from two evolutionary lines of programming languages: an academic line, represented by Niklaus Wirth's Pascal, Modula-2, and Oberon languages; and an industrial research line, represented by the Mesa, Cedar, and Euclid languages from Xerox's Palo Alto Research Center (PARC). Its immediate precursor is an extended version of Modula-2 called Modula-2+, which was developed at SRC in the early 1980s and used there for the development of all its research systems.

In 1986, an effort to clean up Modula-2+ became a design for a new language, christened Modula-3 with Niklaus Wirth's blessing. The language and two working implementations by SRC and Olivetti were completed in 1989 (see figure 1). The SRC implementation is available; I'll tell you how to get it later.

Modula-3 is a systems programming language based on two general principles: simplicity and safety. Programming can be a difficult, complicated, and risky activity, made even worse by programming languages that are themselves difficult, complicated, and risky.

Rather than spending their time inventing clever solutions for textbook programming problems, Modula-3's designers selected features proven through experience in other languages, especially features that support good program structure (modules, objects, threads) and those that support robustness (garbage collection, isolation of unsafe code, and exceptions). They simplified and unified the underlying language concepts, discarding features that did not pull their own weight.

Basics

To get a feel for Modula-3, start with Modula-2, Ada, or one of the modern Pascal dialects (Turbo Pascal or Apple's Object Pascal). The general syntax of statements, expressions, and declarations is similar to that found in the other languages. The customary basic data types are integers, Booleans, reals, characters, sets, enumerations, arrays, records, and pointers.

There are also all the arithmetic, logical, and set operations and the usual set of basic statements: conditional (`IF` and `CASE`), loops (`WHILE`, `FOR`, `REPEAT`), blocks, and so on. Modula-3 includes type, constant, procedure, variable, and exception declarations. Like Modula-2 and C, Modula-3 provides procedure types, and its variable names are case-sensitive.

Although it resembles the other languages, Modula-3 has a number of features that you can use to make programs more readable and maintainable.

Readability

Listing 1 and figure 2 show a simple insertion sort procedure in Modula-3. Line 1 has the declaration of an open array parameter, `V`; within the procedure, the bounds of the array will be from `0` to `LAST(V)`. (The expression `FIRST(V)` used in lines 3 and 8 will always be 0, but its use makes the program a bit more readable.) The index variable `i` in line 3 is automatically declared local to the loop body; it cannot be modified except by the `FOR` loop control; and it takes its type from the initial and final values.

Lines 4–13 introduce a nested block with two new variables, `Temp` and `j`. Both variables are initialized where they are declared, and their types are taken from the initialization expressions (`INTEGER`, in both cases).

Lines 8–11 are a `WHILE` loop containing two statements.

Listing 1: *A simple example:* `InsertSort` *in Modula-3 sorts* `V[0]..V[LAST(V)]` *into ascending order. (Line numbers are not part of the code but are included here for reference.)*

```
 1  PROCEDURE InsertSort(VAR V: ARRAY OF INTEGER) =
 2  BEGIN
 3     FOR i := FIRST(V)+1 TO LAST(V) DO
 4       VAR
 5          Temp := V[i];
 6          j    :=i-1;
 7       BEGIN
 8          WHILE j >= FIRST(V) AND V[j] > Temp DO
 9             V[j+1] := V[j];
10             DEC(j);
11          END;
12          V[j+1] := Temp;
13       END
14     END;
15  END InsertSort;
```

Listing 2: `InsertSort` *demonstrates more features of data-type declarations.*

```
TYPE
   A_type = ARRAY [1..10] OF INTEGER;
VAR
   A := A_type{1,9,3,5,4,..};
BEGIN
  InsertSort( V := A );
END
```

Modula-3 permits multiple statements wherever a single statement is allowed, so there is no need to clutter your program with extra `BEGIN-END` brackets. The `DEC` (decrement) statement in line 10 is equivalent to `j:=j-1`. Modula-3 also has an `INC` statement. Both can take an optional second argument to specify how much to increment or decrement the first argument.

More features can be seen in the code of listing 2, which calls `InsertSort`. The declaration of the fixed array `A` uses an array constructor to create an initialized array. The ".." indicates that the last value in the list (4) is used to fill out the remaining elements of the array. The call on `InsertSort` demonstrates the use of the optional parameter names at the site of the call.

Modules

The backbone of Modula-3 programming is the module. Modules come in two pieces: the *interface* part, which contains the public types, objects, and procedures provided by the module; and the *implementation* part, which contains private declarations and the bodies of the public procedures. To use the public facilities of a module in another module, you must import the compiled interface of the referenced module. You don't actually need the implementation part to compile your module, but you will need something (at least some "stub" code) in the implementation to have a program that runs.

The module concept is a very powerful tool supporting information hiding, abstraction, and top-down programming. Listing 3 shows a complete example of module `Unique` that provides a `Next` procedure, which returns successive integers in the sequence 1, 2, 3. A `Reset` procedure is provided to restart the sequence at a specified point.

The interface (lines 1–5 of listing 3) and implementation

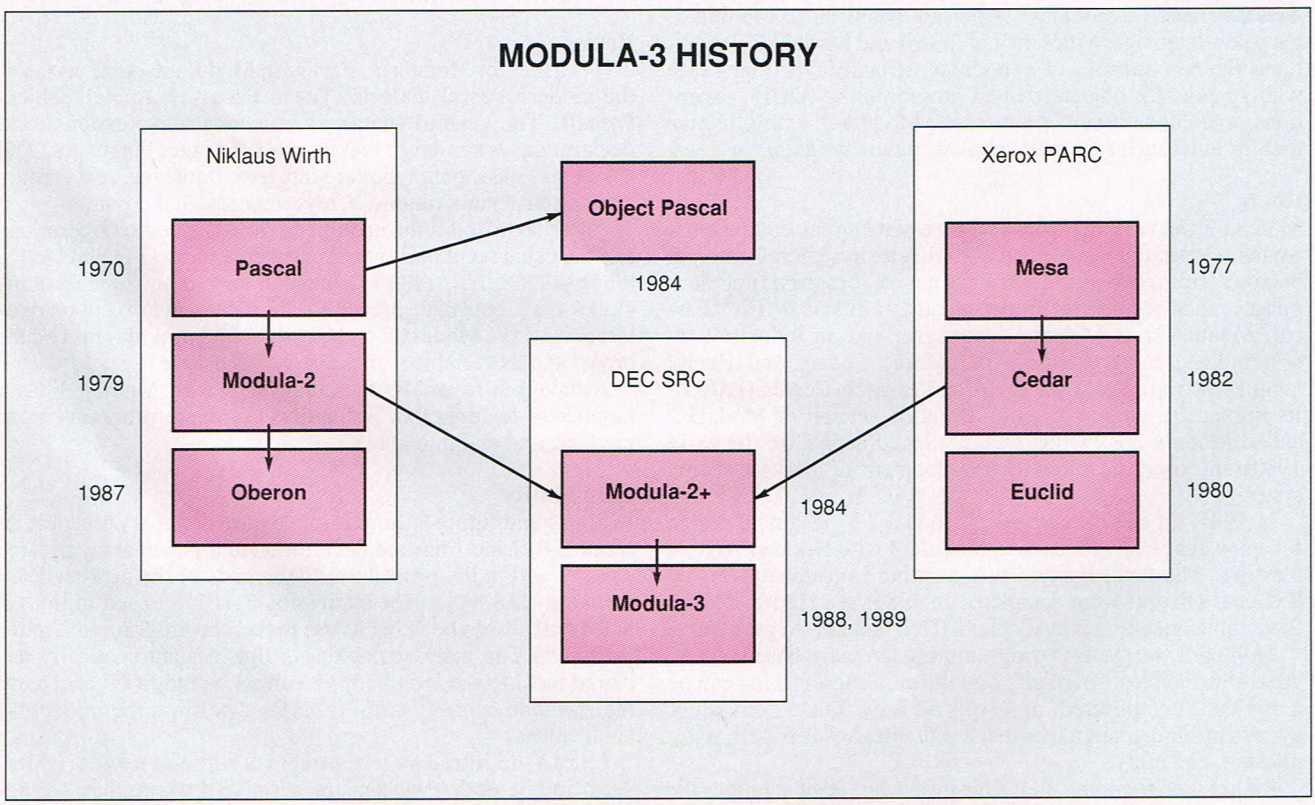


Figure 1: *Modula-3 is a descendant of the work of Niklaus Wirth (the designer of Pascal and Modula-2) and of Cedar from Xerox PARC.*

(lines 6–28) of the module would normally be contained in separate files. The interface declares the two public procedures and a constant integer; this is the only information a user of the module needs to know.

The implementation part of `Unique` imports two standard library interfaces, `Wr` and `Stdio`, which implement simple text streams. There are actually two ways to import an interface. For one, if you specify only the interface name (as on line 7), all names from that module must be qualified by the interface name (e.g., `Wr.PutText` on line 15). However, if you list individual names (as on line 8), you can use them without qualification (e.g., the `stderr` on line 15). In either case, the origins of the imported names are explicit in the program, making it easy for any reader to locate the proper interface. It is possible to import interfaces into other interfaces, but that wasn't necessary in this example; the I/O is performed only in the private part of the module.

In line 9, a static integer variable, `Next_Value`, is declared at the top level of the module and is initialized in the module's body (lines 26–28). (Stylistically, it is better to initialize `Next_Value` where it is declared, but I wanted to show the module body.) The Modula-3 compilation system ensures that each module's initialization code is executed in the proper order, that is, before the module's facilities are used by any other module. One module must be designated as the main module; that module's initialization code becomes the program entry point, executed after all other modules have been initialized.

Line 22 shows the procedure declaration for `Reset` with a default parameter value. As a result of this kind of declaration, if `Reset` is called without parameters, the `Next` parameter takes on the value `First_Value`, or 1.

Listing 3: *Interface and implementation parts to a module.*

```
 1  INTERFACE Unique;
 2     CONST First_Value = 1;
 3     PROCEDURE Next() : INTEGER;
 4     PROCEDURE Reset( Next := First_Value);
 5  END Unique.
 6  MODULE Unique;
 7     IMPORT Wr;
 8     FROM Stdio IMPORT stderr;
 9     VAR Next_Value : INTEGER;
10     PROCEDURE Next() : INTEGER =
11     VAR
12        This_Value := Next_Value;
13     BEGIN
14        IF Next_Value = LAST(INTEGER) THEN
15           Wr.PutText(stderr,"Next() is wrapping around0);
16           Next_Value := FIRST(INTEGER); (* e.g., -2**31 *)
17        ELSE
18          INC(Next_Value);
19        END;
20        RETURN This_Value;
21     END Next;
22     PROCEDURE Reset( Next := First_Value ) =
23     BEGIN
24        Next_Value := Next;
25     END Reset;
26  BEGIN
27     Next_Value := 1;
28  END Unique.
```

Exceptions

An *exception* is an event that suspends normal program execution and causes control to be transferred to a *handler* for that exception. After the exception is handled, execution resumes at some well-defined location in the program, but not necessarily

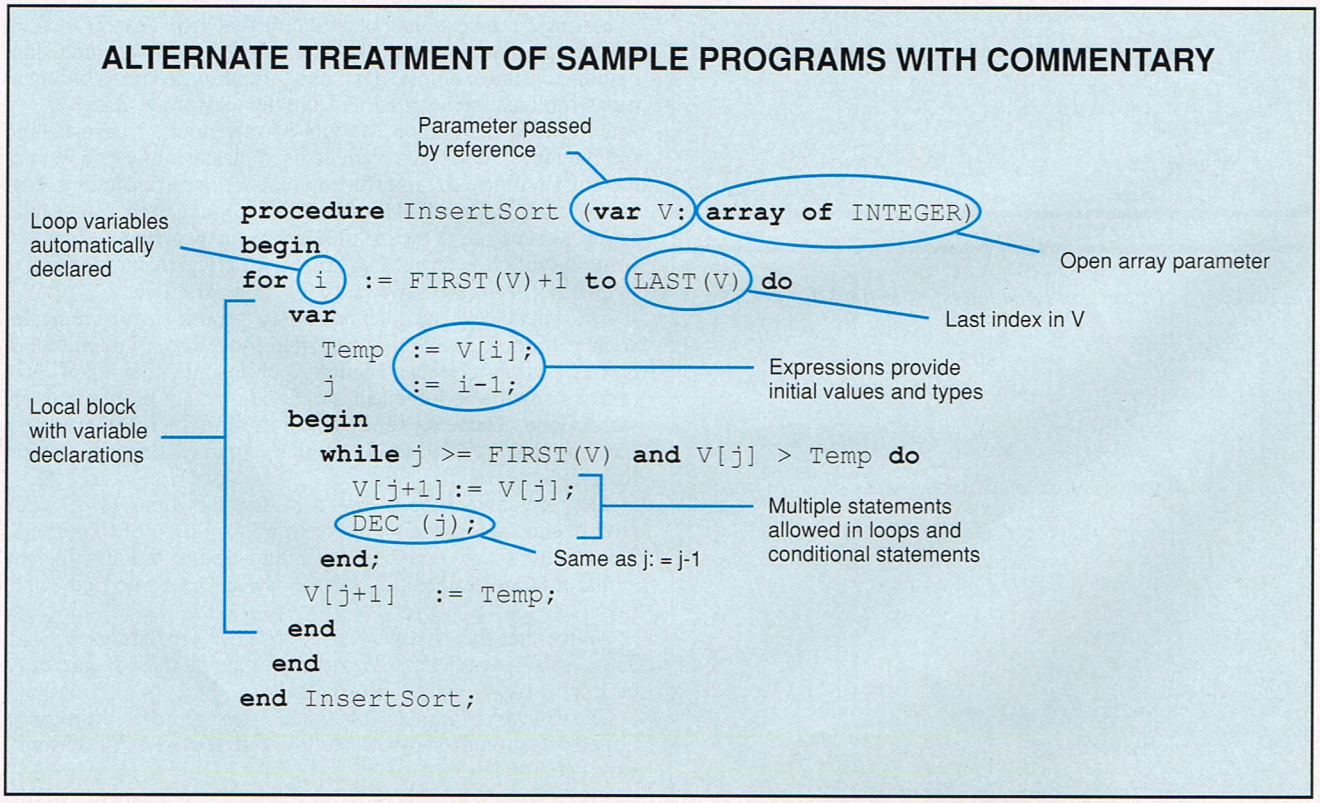


Figure 2: *Although Modula-3 looks very much like Pascal and Modula-2, declarations can incorporate initial values, and data typing can be implicit.*

where the exception was first raised.

Exception-handling mechanisms are important for robust programs. Without them, you must manually check status values returned by all procedure calls or depend on awkward library facilities. Modula-3's exception mechanism is similar to the one used in Ada; it has low overhead and is easy to use. Listing 4 shows an interface, Copy_Stuff, that uses exceptions. A portion of the implementation of Copy_Stuff is also shown, along with a main module that uses it.

Listing 4: *An example of Modula-3 exceptions.*

```
1  INTERFACE Copy_Stuff;
2       EXCEPTION Error (TEXT );
3       EXCEPTION  EOF;
4       PROCEDURE GetText() : TEXT RAISES {Error,EOF};
5       PROCEDURE PutText(T: TEXT) RAISES {Error};
6  END Copy_Stuff.
7  MODULE Main;
8       FROM Copy_Stuff IMPORT GetText,PutText,Error,EOF;
9       FROM OSIO IMPORT Exit, Success, Failure;
10      VAR Buffer : TEXT;
11 BEGIN
12      TRY
13         LOOP
14            Buffer := GetText();
15            PutText(Buffer);
16         END;
17      EXCEPT
18       EOF   => Exit(Success);
19       Error => Exit(Failure);
20      END;
21 END Main.
22 MODULE Copy_Stuff;
23    IMPORT OSIO;
         ...
24    PROCEDURE GetText() : TEXT RAISES {Error,EOF} =
25    BEGIN
      ...
26       Status := OSIO.LoadBuffer();
27       IF Status = OSIO.Error THEN
28          RAISE Error("OS error reading file");
29       ELSIF Status = OSIO.EOF THEN
30          RAISE EOF
31       END;
32    END GetText;
      ...
33 END Copy_Stuff.
```

Listing 5: *Objects and opaque types in Modula-3.*

```
1  INTERFACE Point;
2       TYPE
3          T <: Public_T;
4          Public_T = OBJECT
5             METHODS
6                PosX( ) : REAL; (* X position *)
7                PosY( ) : REAL; (* Y position *)
8             END;
9       <*INLINE*> PROCEDURE New(x, y: REAL) : T;
10 END Point.
11 MODULE Point;
12      REVEAL
13         T = Public_T BRANDED OBJECT
14               X, Y : REAL;
15            METHODS
16               PosX := PosXProc;
17               PosY := PosYProc;
18            END;
19    PROCEDURE New(x, y: REAL) : T =
20      BEGIN
21       RETURN NEW(T, X:=x, Y:=y);
22      END New;
23    PROCEDURE PosXProc( p: T) : REAL =
24      BEGIN RETURN p.X; END PosXProc;
25    PROCEDURE PosYProc( p: T) : REAL =
26      BEGIN RETURN p.Y; END PosYProc;
27 BEGIN
28 END Point.
```

The exception declarations appear in lines 2 and 3; the Error exception takes a parameter of type TEXT (a Modula-3 dynamic string). Notice that GetText and PutText explicitly list the exceptions they may raise (lines 4 and 5); this optional declaration improves readability and maintainability. (The compiler will check that no unlisted exceptions are propagated out of the procedures at run time.)

The central code in Main is simply an infinite loop (lines 13–16), which is terminated when an exception is propagated out of either GetText or PutText. The surrounding TRY-EXCEPT statement (lines 12–20) holds the two exception handlers (lines 18 and 19), which terminate the program with or without an error. The excerpt from the implementation of GetText (lines 24–32) shows how the exceptions might be raised.

Objects

OOP is becoming an increasingly popular tool for the programmer. Its advantages include increased maintainability and extensibility of code. There are three critical elements needed in languages that support OOP:

- The ability to define classes (types) of objects that include their own data and methods (procedures).
- The ability for a class to inherit data and methods from another class (its ancestor), and to change or extend them.
- The ability to create objects (instances of classes) and access data and methods through those objects.

Modula-3 provides all these elements of OOP. In fact, by providing both modules and objects, Modula-3 gives the programmer much more flexibility than languages that provide only one (e.g., Modula-2 and Ada) or the other (e.g., C++).

Listing 5 is an example of a module that provides the abstraction of a geometric point, that is, a location in a two-dimensional plane. In the example, particular attention is paid to hiding as much information as possible from the user of the class.

Following a common Modula-3 convention, I have named the interface Point and the enclosed class simply T. Users of the class will use the interface name as a qualifier and call the class Point.T. Line 3 identifies T as an *opaque type*: the declaration T<:Public_T means that T is an unspecified descendant (subtype) of class (type) Public_T, which is declared in line 4 as an object type with two methods, PosX and PosY.

The interface also declares a New procedure to create instances of the class. New is a normal procedure, not a method. Its declaration reflects a Modula-3 philosophy that not all procedures should be forced into methods if they more naturally stand alone. The text <*INLINE*> is a Modula-3 "pragma" requesting that the Modula-3 compiler expand all calls to New inline.

The implementation of Point is shown in lines 11–27. The first declaration reveals the concrete definition of the type T, introducing its two data fields, X and Y, and establishing the actual method procedures for the class, PosXProc and PosYProc.

Notice that the first parameter to these procedures is p: T. This "self" parameter was implicit in the method declarations on lines 6 and 7.

The keyword BRANDED on line 13 ensures that the type is unique. It is required by the Modula-3 type system for reasons I won't go into here.

The Point.New procedure on lines 19–22 is worthy of discussion. It calls the built-in Modula-3 function NEW to dynamically allocate an object, and it can set the values of any data field or method; that is, Modula-3 objects from the same class

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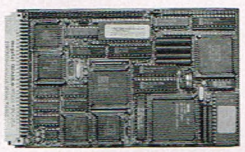
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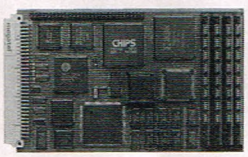
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can have different methods installed when they are created. This is a powerful feature not found in many object-oriented languages. In this example, only the data fields are set by NEW; the default methods provided on lines 16 and 17 are retained.

As implied in the example, all Modula-3 objects are dynamically allocated. In Modula-3, there are no constructors or destructors to create and destroy objects automatically. Programmers must write explicit initialization routines or allow the user to invoke NEW directly. Destructors in other languages are most often used to deallocate dynamic storage. But since Modula-3 has automatic garbage collection, destructors are not usually needed.

Threads and Programming for Concurrency

Concurrent programming—the management of multiple, simultaneous control flows—is the third major structuring facility in Modula-3 (after modules and objects). Concurrency is useful in many programming situations: when you want to take advantage of multiprocessing; when you want to provide background processing during slow user interactions; and when you are handling naturally asynchronous or independent tasks, like handling separate windows in a graphical user interface.

Few other languages provide direct support for concurrency: Modula-2 provides a weak coroutine-based facility, and Ada a complex rendezvous mechanism. In contrast, Modula-3 adopts the *thread* model in which concurrent threads of control are managed within the same program and address space, each with its own local call stack but with shared access to all global data. This is the model increasingly supported by new operating systems. Threads are typically much more efficient than *processes*, which are identified with a separate address space.

A detailed example of programming with threads is outside the scope of this article. Suffice it to say that Modula-3 has a standard library interface that provides facilities to fork and join threads, to use mutual-exclusion semaphores and condition variables, and to alert (interrupt) running threads.

Safety

Safety is a principal goal of Modula-3. Most of the language is safe in the sense that the compiler guarantees that run-time invariants (e.g., variable ranges, array indexes, and the validity of pointers) are not violated. In contrast to this, Appendix F in the ANSI C standard lists 97 different circumstances in which the behavior of a C program is undefined at either compile time or run time. Modula-3 guarantees safety through a combination of compile-time analysis and run-time checking. This can vastly reduce the time it takes to debug a large application.

Systems programming can be unsafe by its very nature. Storage allocators and garbage collectors typically must have access to the unsafe features of a language. In Modula-3 these features include the ability to perform arbitrary type coercions, to perform arithmetic on pointers, and to call the DISPOSE procedure to explicitly free dynamic memory allocated with NEW.

To use the unsafe language features, you must insert the modifier UNSAFE in your interface or module. Otherwise, the compiler will restrict you to the safe language subset. A good way to include unsafe elements into Modula-3 programs is to create a module with a safe interface for others to use, and then to implement that interface with an unsafe module. You must be the guarantor that using the interface is safe; Modula-3 cannot completely check it.

Garbage Collection

Some of the most insidious run-time errors are caused by misusing pointers, especially by using pointers after the storage

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they point to has been deallocated. Modula-3 removes this problem once and for all by providing automatic garbage collection in the run-time environment. Since the programmer using the safe language cannot write a `DISPOSE` operation, the compiler can guarantee that no storage will be freed if there are outstanding references to it. Dangling references are a thing of the past, and programming becomes much simpler when you do not have to worry about storage management.

There is a side benefit to garbage collection. Since type information must be kept for pointer types, using the `REFANY` type (a pointer to anything) is safe, and the `TYPECASE` statement can be used to determine the type of a pointer at run time.

Points of Contention

There are a few design choices in Modula-3 that some programmers will question. In all cases, the choices were made deliberately, and usually because either the alternative had little (proven) utility, it was too complex in all its ramifications, or it was unsafe.

Modula-3 is biased toward dynamic allocation. Introducing garbage collection was a calculated technological bet. Do the value of program safety and the efficiency of modern collection algorithms together make garbage collection acceptable in a systems programming language? I think so, but for the doubters, Modula-3 doesn't completely depend on garbage collection: The modifier `UNTRACED` can be applied to any pointer or object type to keep it from the collector (even in the safe language subset).

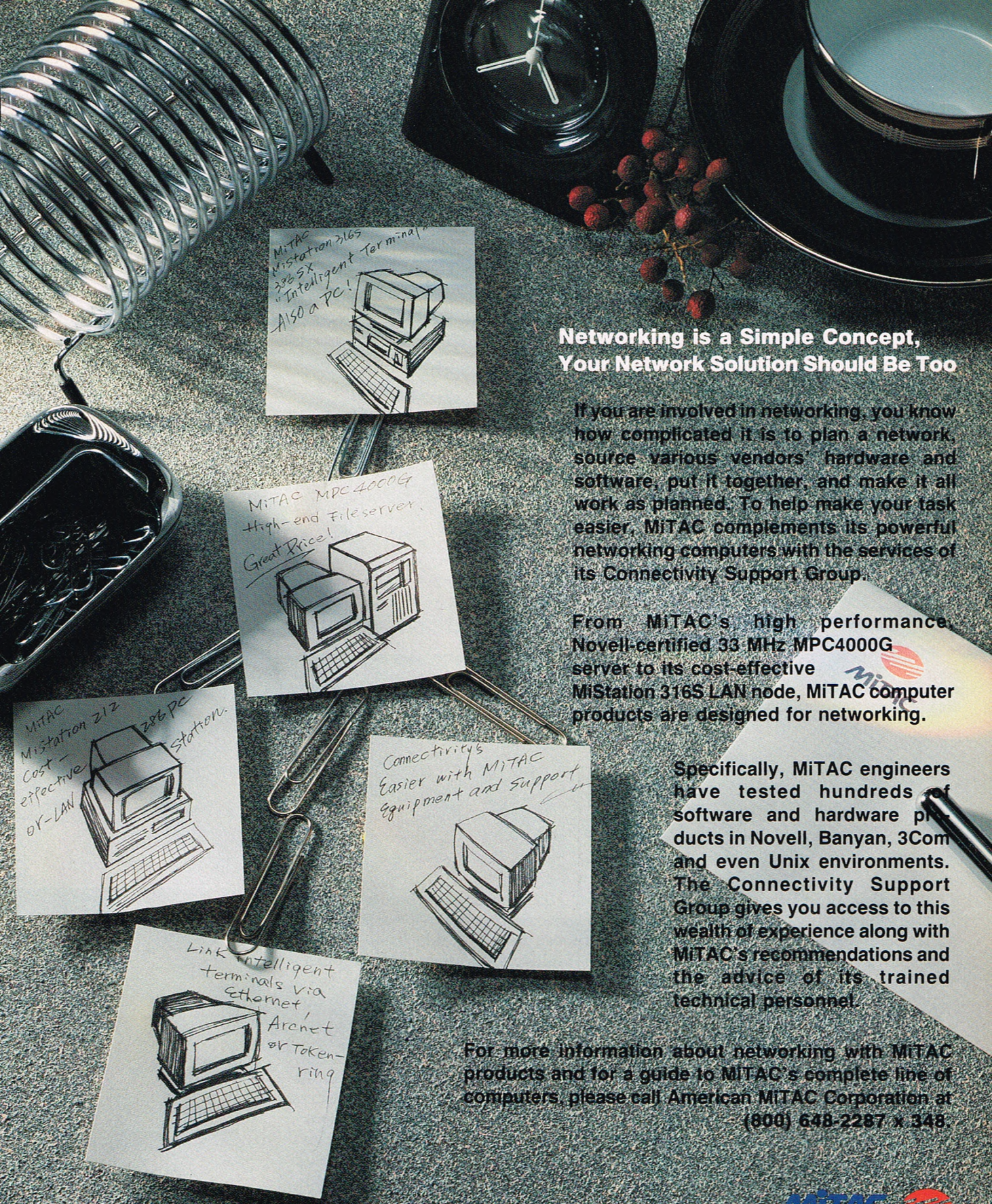
Even though Modula-3's OOP model is flexible and is simpler than that of many other languages, Modula-3 does not support multiple inheritance, constructors, or destructors, and all methods are virtual (to use C++ and Eiffel terminology). This means that you must pay for a level of indirection in all method calls, but nonvirtual methods can be written as ordinary procedures if efficiency is important. Multiple inheritance doesn't seem to be essential, and, besides, it introduces additional complexity and problems whose solutions require additional features.

On the other hand, Modula-3's data-type system uses a structural-equivalence model. In other words, two types are always treated as the same if their structure is the same. This model is simpler to understand than the more common name-equivalence model, and it more naturally addresses problems in distributed systems, where separate programs may share typed data.

Modula-3 makes a serious attempt to bring together the long-term maintainability of Ada, the simplicity of Modula-2, and the modern OOP facilities of C++. The result is a clean language that provides programmers who want safety and maintainability with a language to carry them through the 1990s.

If you would like more information on the Modula-3 language, you can write for Research Reports 52 and 53 from Digital Equipment Corp., Systems Research Center, 130 Lytton Ave., Palo Alto, CA 94301. The SRC implementation of Modula-3 is also available on Internet and via UUCP (Unix-to-Unix copy). The system consists of a Modula-3-to-C translator with many tools and libraries. It is distributed in source form and has been ported to a variety of Unix workstations. It is available on BIX as modula.3; see page 5 for more information and downloading details. ■

Sam Harbison (Pittsburgh, PA) is the author of C: A Reference Manual *and president of Pine Creek Software, a consulting firm specializing in programming languages and environments. He can be reached on BIX as "samharbison."*



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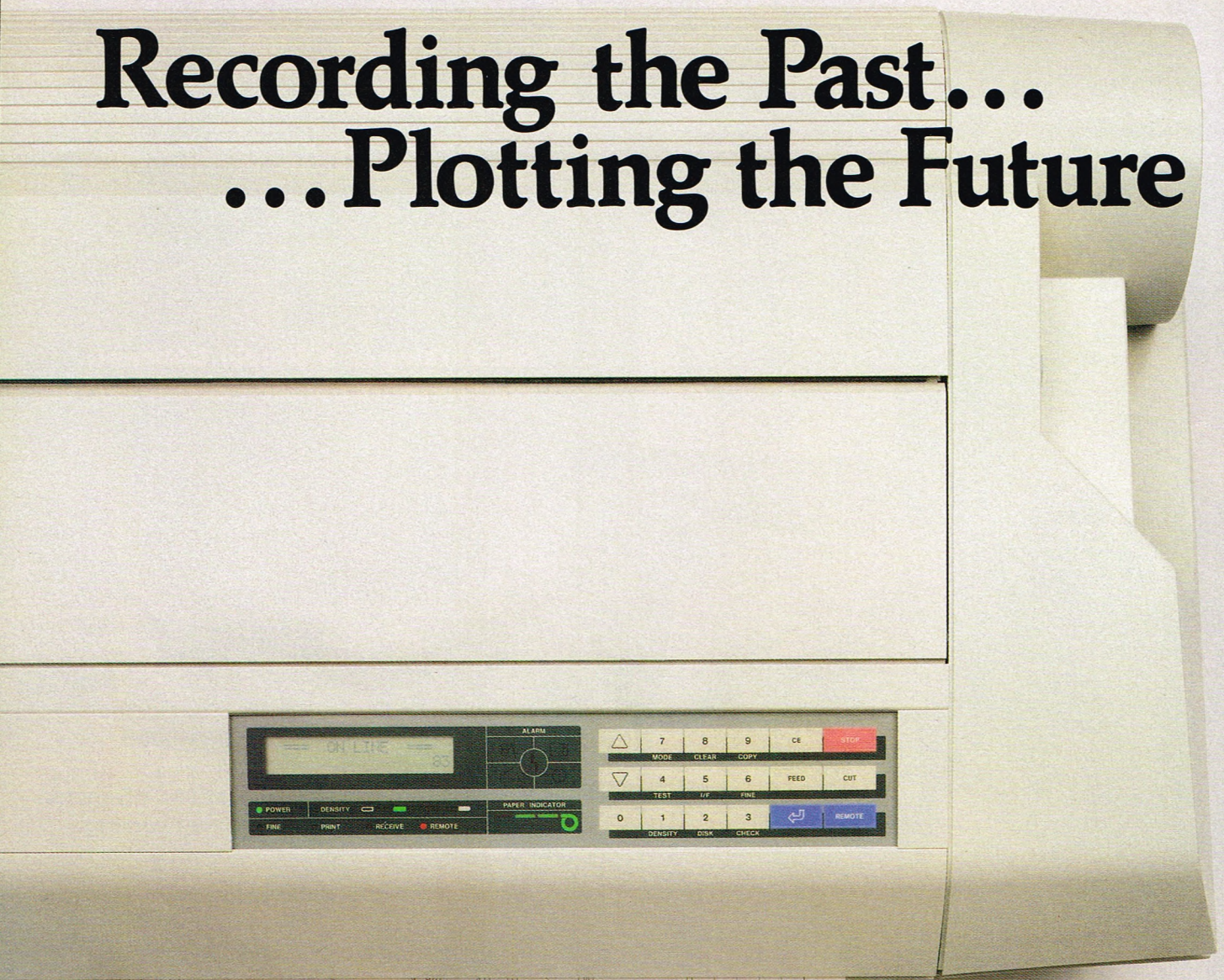
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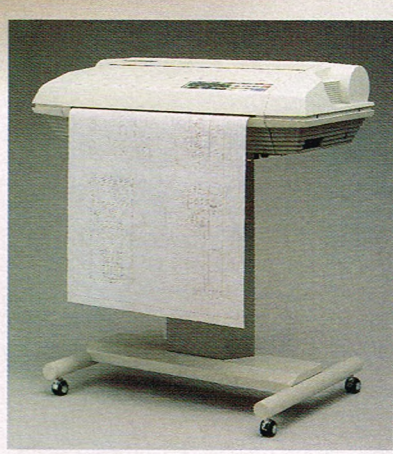


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The Way it Was

Douglas Engelbart invented the mouse in 1963, at the Stanford Research Institute. At that time Engelbart was exploring various computer input device possibilities. His first prototype mouse was made of wood, with metal disks for rollers that detected the mouse movement. After using the mouse, Engelbart concluded that it was superior to the other alternatives and that it would remain the best pointing device for computer users until something better came along.

Xerox further developed the mouse concept in the early 1970s at its Palo Alto Research Center (PARC), under the direction of Jack S. Hawley. Unlike Engelbart's mouse, which used variable resistors and an A/D conversion circuit, Hawley's was the first digital mouse. Much of Hawley's basic design has been carried into the modern PC mouse.

In 1982, Mouse Systems introduced the first mouse for the IBM PC. With no real software available with mouse support, initial sales of the three-button mouse were primarily to computer users who were curious about the creatures, and those attracted to the novelty.

Around that time, Microsoft also started seeing the mouse as a device with a lot of potential in the PC marketplace and, being a software company, the company had the wherewithal to encourage mouse use by writing mouse support into its software.

Microsoft introduced its own two-button PC mouse in mid-1983. With the subsequent introduction of such programs as Microsoft Word, and later Windows and Excel, Microsoft showed PC users that a mouse can make working on computers easier and more efficient (and more fun).

When the Macintosh appeared in 1984, sporting a mouse and a user-friendly GUI, users everywhere became even more aware of the benefits of the mouse. Meanwhile, mouse-supporting applications continued to trickle into the PC marketplace.

Mouse vendors further encouraged mouse use by supplying pop-up menus that allowed their mice to work with standard nonmouse applications. Mouse-based PC paint programs also began to appear, and it was common to buy a mouse that included a bundled paint program.

The use of mice on PCs continued to grow. In mid-1988 Microsoft recorded its one-millionth mouse sale and ended the 1990 fiscal year in June with nearly two million mouse sales—about half of all PC mice sold that year. Other major mouse suppliers have also benefited from the increased popularity of mice, including Logitech, Mouse Systems, and IBM. According to International Data Corp. (Framingham, MA), 1989 mouse sales in the U.S. totaled around 3.2 million units, with worldwide sales for that year of around 5.5 million units.

As Engelbart predicted, the mouse has indeed withstood the test of time. There are far more mice on PCs than any of the alternative pointing devices (i.e., trackballs, graphics tablets, light pens, and touch-screens).

Mouse Anatomy

Mice come in two species: mechanical and optical. Mechanical mice, in turn, belong to two subspecies: electromechanical and optomechanical.

Figure 1 illustrates the operation of an electromechanical mouse. A rubber-coated metal ball protrudes from the bottom of the mouse; as you move the mouse, it turns. Two rollers touching the ball record its movements along the x and y axes. As the rollers rotate, encoders make and break electrical contacts that send electrical pulses the computer can use to track the mouse.

Alternatively, some mechanical mice, like the Manager Mouse from Numonics, don't use a roller ball. Instead, two rollers protrude from the bottom of the mouse to sense the x and y directional movements.

The optomechanical mouse illustrated in figure 2 works differently. LEDs shine through holes in the encoders onto photodetectors. As the rollers rotate, the encoders alternately make and break light beams between the LEDs and the photodetectors. Corresponding electrical signals sent to the computer describe the motions of the mouse.

Note that the optomechanical mouse needs two LED/photodetector pairs in order to determine the direction of rotation. A single LED/photodetector pair can only determine rotational speed.

Figure 3 shows how an optical mouse works. It requires a special reflective mouse pad with a grid of black and blue lines. The mouse has two LEDs that shine onto the mouse pad, one red and one infrared. The reflected light beams reenter the mouse through lenses, and then reflect onto photodetectors. The blue lines absorb the red light, and the black lines absorb the infrared light. As the mouse moves, the pad alternately absorbs and reflects light. The photodetec-

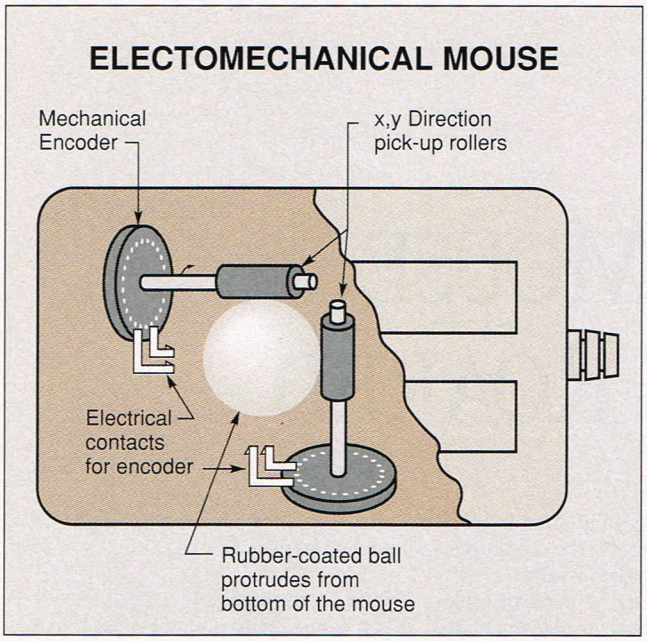


Figure 1: *In an electromechanical mouse, a rubber ball drives the encoders, which make and break electrical contacts.*

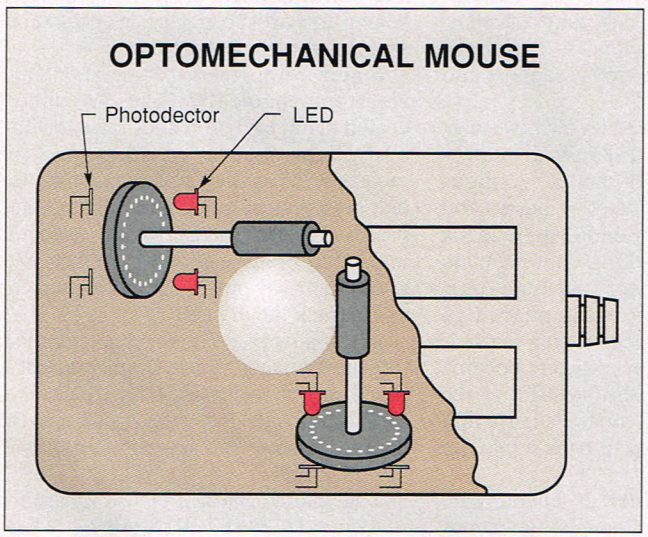


Figure 2: *As with an electromechanical mouse, a rubber ball inside an optomechanical mouse drives the encoders. In this case, however, LEDs shine through holes in the encoders. The optical encoding scheme eliminates wear on the encoders.*

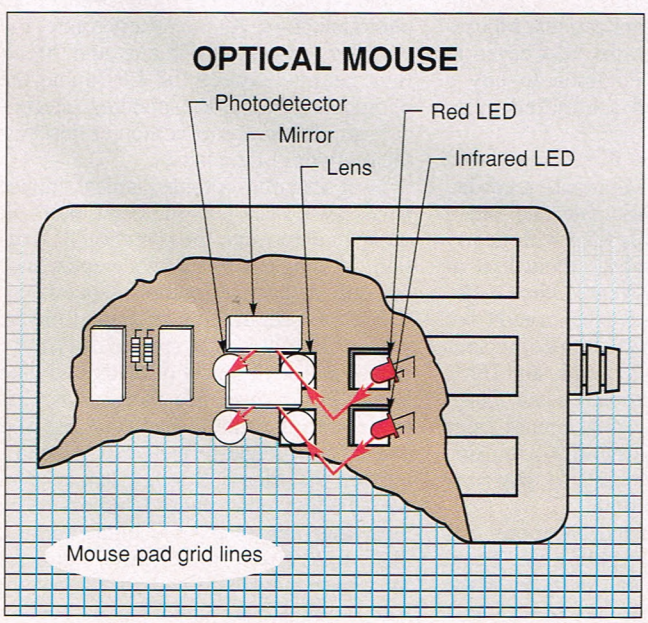


Figure 3: *Red and infrared LEDs shine from an optical mouse onto a special pad. Reflected beams pass through lenses, then reflect onto photodetectors.*

tors detect the "makes" and "breaks," which the mouse converts to signals that it sends to the PC. As with all species of mice, additional signals tell the computer about push-button events.

Most PC mice have either two or three push buttons (in contrast to the Mac's single button). Mouse-based PC programs generally require just two buttons, but can often assign a function to a third button. Mouse push buttons can also work in combinations (e.g., two buttons simultaneously) to specify other functions. Some programs support the double-click—two button presses in rapid succession—to specify more functions.

What are the relative merits of optical versus mechanical mice? Optical mouse proponents claim greater reliability for their favorite, thanks to its solid-state, no-moving-parts design. The "opticians" also point out that the optical mouse is maintenance-free, unlike mechanical mice, which require periodic cleaning of the roller ball to eliminate the inevitable build-up of foreign substances. They also claim the optical mouse is more accurate. If an optical mouse moves from one point to another on its mouse pad, then back, the cursor on your screen should be back exactly where it started. In contrast, the mechanical nature of mechanical mice makes them more susceptible to slight variations, including minor ball skipping and alterations in the registration of the roller ball to the encoder shafts. Move a mechanical mouse from one point to another and back, and you'll typically find the cursor slightly off its starting point.

The mechanical-mouse proponents argue that modern mechanical mice have shown no reliability penalty, and that the roller ball rarely needs cleaning—especially when used on a rubber mouse pad. Furthermore, the mechanical mouse doesn't *need* a pad, as an optical mouse does. Some users don't want to give up the desk space, or restrict the mouse to a limited field.

Finally, the mechanical design more readily accommodates higher mouse resolutions. You can cram only so many black and blue lines onto an optical mouse pad before you begin to lose the ability to resolve them.

What about the two species of mechanical mice? Electromechanical mice suffer from a couple of problems that their optomechanical cousins solve. With an electromechanical mouse, the electrical contacts on the encoders can "bounce" a bit. This affects accuracy and requires a compensating circuit design. Electromechanical mice also tend

to wear out their encoders, since there are always points of physical contact. The optomechanical design eliminates bounce, and there's no encoder wear (except at rotational joints). The optoelectronic design of the encoders also supports higher resolution. Most high-resolution mice are optomechanical (although the 350-point-per-inch PC Mouse III optical mouse from Mouse Systems is the exception to this rule).

The Resolution Revolution

The resolution of a mouse refers to the number of points it can detect for every inch of movement. The distance between two adjacent points (the shortest distance the mouse can resolve) is measured in a half-dozen different units. Programmers who work with mice have whimsically coined the unit *mickey*, but the industry is using more common ones, including dots per inch (dpi), counts per inch (cpi), pulses per inch (ppi), and points per inch (another ppi, and the one used for this article).

Early mice, like the original Microsoft mouse, had a resolution of 100 ppi. Most of today's mice have a 200-ppi resolution, as did Microsoft's second- and third-generation mice. Some newer high-resolution mice register between 320 and 400 ppi, including Microsoft's latest 400-ppi entry. There has been some debate over the necessity of resolutions as high as 400 ppi, but some users claim smoother mouse operation on high-resolution screens when using a high-resolution mouse.

Mouse Interfaces

In what form do the signals enter your PC, and how does the PC process them? That depends. Three primary types of mouse interfaces are common in the PC world: bus, serial, and special port.

The earliest mice were bus mice. They came with a half-size interface board that plugged into one of the PC's expansion bus slots; the board drew its power from the expansion bus. The board processed signals from the mouse, and periodically generated interrupts to pass mouse movement and button-press information to the mouse driver.

Microsoft made a substantial contribution to the PC mouse market when it introduced a serial version of its mouse in 1984. The serial mouse could plug into a standard COM1 or COM2 RS-232C serial port. It didn't need a bus interface board or any other external circuitry. The mouse included a small controller that sent packets of information to the PC via the serial port. The controller required so little power that it could operate without an external power source, simply by drawing its power from the RS-232C request-to-send (RTS) handshake line. This became a trend in the mouse industry, and now most mice are of the serial variety.

I should mention one caution concerning the use of serial mice with laptop computers. Since these mice draw their power from the serial port itself, they expect to see the typical PC voltage of around +12V on the RTS handshake line. When laptops are operating on battery power, however, a lower voltage is often used to generate the serial-port signals. This prevents many serial mice from working properly with the system. If you use the laptop's AC adapter, of course, there won't be a problem.

If you don't count Microsoft's brief flirtation with its Mach 10 PC turbo board (using the company's proprietary InPort mouse interface), IBM was the



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first company to include a mouse port (aka, "pointing device" port) on its systems. The mouse port on IBM's PS/2 systems (Models 50 and up) is essentially a bus-mouse interface built into the system motherboard.

Some of the newer bus mice have taken a different approach to implementing the PC/mouse interface. Rather than offer two different mice—one serial and one bus—some manufacturers combine the two into a single serial mouse. The "bus interface" in this situation is functionally little more than a standard serial port that maps to an I/O address other than COM1 or COM2.

How Serial Mice Communicate

Serial mice send multiple-byte packets of information to the PC to indicate the directional movement of the mouse and the status of the mouse push buttons. A couple of packet formats have emerged as the predominant standards in the industry. Most applications, however, don't need to worry about them; the mouse driver hides the packet formats.

The two-button Microsoft packet format is the most popular format in use. The packet comprises 3 bytes; only the 7 low-order bits of each byte are significant. The first byte includes the 2 high-order bits of both the *x*- and *y*-position values, and the status of the two push buttons. The second byte contains the remaining 6 low-order *x*-position bits, while the third byte contains the remaining 6 low-order *y*-position bits.

The 8-bit binary position values are in two's-complement format (ranging from −128 to +127), with a negative value indicating movement left or up, and a positive value indicating movement right or down. The mouse sends the packet only when there's a change of state, such as a movement of the mouse or a press or release of a button. The *x*- and *y*-position values sent in the packet indicate the number of points the mouse has moved in each direction since the last packet.

Transmitting only an 8-bit value for each direction isn't a limitation—even for high-resolution mice—because the values indicate only the *change* in mouse position since the last packet was sent.

For example, a typical serial mouse operates at 1200 bps. That means each byte needs about 7.5 milliseconds to pass from the mouse to the PC (7 data bits, 1 start bit, and 1 stop bit), and each 3-byte packet takes about 22.5 ms. Each packet can specify a maximum position change value of 127 (in each positive direction), so the mouse can specify a position change of up to 5644 (127/0.0225) points per second. Even with a 400-ppi mouse, this scheme allows for movement of over 14 inches per second.

Of course, the baud rate can always be increased if this becomes a limitation. At 9600 bps, a serial mouse using the 3-byte Microsoft packet format can support a velocity of up to 112 inches per second.

The three-button Mouse Systems packet format comprises 5 bytes. The first byte reflects the current state of the three buttons. The second byte specifies the "first" *x*-position value and the third byte specifies the "first" *y*-position value. The fourth and fifth bytes are similar to the second and third, but specifying the "second" *x*- and *y*-position values instead of the first; that is, the change in the *x*- and *y*-positions since the readings sent in the second and third bytes. This can, for example, be helpful in determining mouse velocity.

As with the Microsoft packet format, the *x*- and *y*-position values are in two's

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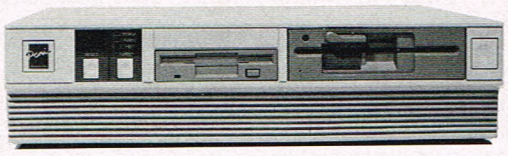
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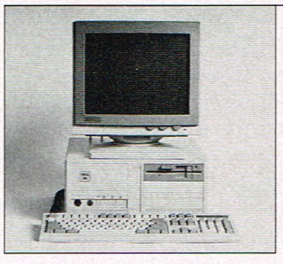


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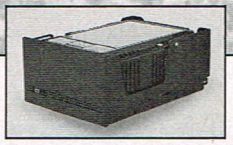
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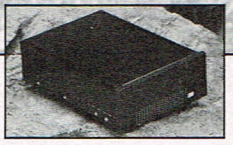
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complement format. A positive value indicates movement right or up; a negative value indicates movement left or down.

The Software Perspective

It is probably obvious that Microsoft has set the standard for PC mice. You'd be hard-pressed to find one that doesn't tout "Microsoft Mouse compatibility."

DOS applications generally access the mouse movement and button information by making calls to a mouse driver. Virtually every PC mouse includes a mouse driver that emulates the Microsoft Mouse driver to make the mouse look like a Microsoft Mouse to the application. Many mice also come with a driver to emulate a Mouse Systems PC Mouse.

Interestingly, the mouse driver interacts directly with the video adapter to control mouse cursor movement. The driver must therefore include support for the video adapter you use to ensure proper operation on your system. Naturally, all current mouse drivers support the standard video adapters, including MDA, CGA, EGA and VGA, but if you are using something a little newer (like an 8514/A adapter) or something out of the ordinary, the mouse driver may not support it. Check if you are unsure.

Microsoft's mouse driver supports 35 function calls (see the table). The driver offers a lot of flexibility to the mouse programmer. While it is not possible to describe all the functions in detail here, I will briefly describe some of them.

The Mouse Reset and Status function (0) sets several mouse parameters to default values (e.g., the mickeys-per-pixel ratio), and returns the current status of the mouse; that is, whether or not the mouse has been found, and which mouse buttons, if any, are currently pressed. This function also hides the mouse cursor on the screen if it is displayed.

The Show Cursor and Hide Cursor functions (1 and 2) control whether or not the mouse displays its cursor on the screen. A counter value determines when to display the cursor. When the counter is 0 the cursor appears, otherwise it does not. The counter decrements with each Hide Cursor call and increments with each Show Cursor (although it cannot be incremented past 0). Thus, it takes three Show Cursor calls to undo three Hide Cursor calls.

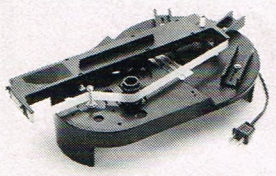
The Get Button Status and Mouse Position function (3) returns the current status of the mouse buttons and the current cursor position on the screen. Beware, however, that the mouse driver uses a "virtual screen" matrix for determining the position of its cursor, and that virtual screen isn't always the same as the physical pixel array on the screen.

In the case of a medium-resolution graphics screen with a 320- by 200-pixel matrix, the mouse's virtual screen would be 640 by 200 pixels. The virtual screen concept is intended to simplify mouse programming. You can address the virtual screen (which is always a minimum of 640 by 200 pixels) and allow the mouse driver to translate the addressed position to the correct location on the display, based on the current video mode. For some high-resolution EGA and VGA modes, the virtual screen expands to 640 by 350 or 640 by 480 pixels, but for all other modes, the virtual screen remains at 640 by 200 pixels.

Function 15, Set Mickey/Pixel Ratio allows you to adjust the mouse sensitivity by selecting the number of mickeys, or points, required to move the mouse cursor eight pixels on the screen. You can set the value to anything between 1 and

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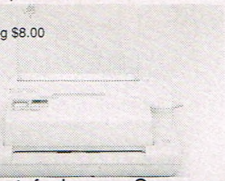
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32,767, inclusive. Another way to adjust the mouse sensitivity is to use Function 26, Set Mouse Sensitivity.

Function 36, Get Driver Version, Mouse Type, and IRQ (interrupt request) Number, returns the mouse driver version, the mouse type (e.g., bus, serial, InPort, or PS/2), and the IRQ number. This information can help determine if the current mouse and driver is compatible with the application.

An application can access a mouse driver in a couple of ways. One option is to link a .LIB file containing the driver with the application program. That way, the application supports the mouse directly. More commonly, however, users install the driver by way of the CONFIG.SYS file (DEVICE=MOUSE.SYS) or the AUTOEXEC.BAT file (MOUSE.COM), and the application accesses the driver functions by making calls to software interrupt 33 hexadecimal.

The *Microsoft Mouse Programmer's Reference* (Microsoft Press, 1989) fully describes the operation of the Microsoft Mouse driver.

MOUSE.SYS and MOUSE.COM work well enough in the DOS world (although I have seen incompatibilities), but the whole picture changes when you switch to a protected-mode operating system. OS/2 and Unix can't use a standard MOUSE.SYS driver to allow a mouse to emulate a Microsoft mouse, because such drivers won't work in protected mode. If these operating systems don't include support for your mouse, you'll need a special driver. Generally, you'll have more options with a serial mouse—particularly one that supports the Microsoft Mouse packet format.

ICBM: Infinitely Configurable Ballistic Mice

An increasing number of mice support a feature known as *ballistic tracking* (or variable acceleration). At times, you may need to use your mouse for some detailed cursor movement at one part of your screen and then move clear across the screen for some further detailed work. Operating at high resolution, the trek across the screen can take a long time, and require several repeated movements of your mouse.

With ballistic tracking, the mouse can detect when you move it faster. As its velocity increases, it automatically changes the number of points per inch to allow faster travel across long distances. As it slows down, it reduces the number of points per inch to again allow more detailed cursor movement.

Ballistic tracking can be implemented with an on-board controller or in the mouse driver software. Although most who have tried it like ballistic tracking (it beats repeatedly pounding your desk with your mouse to get the cursor across the screen) some find it irritating. If you're unsure, make sure your mouse has the option to disable the feature.

A Faithful Companion

The mouse has come a long way in the past five years, but in terms of technology, little has changed. The basic mouse design remains essentially the same, with increments in resolution being the only real thing to show for the longevity of the mouse.

Experience has shown that mice in general are quite reliable, most operate basically as well as others, and resolution is often not a big concern. Some users prefer optical mice because there are no moving parts and nothing to clean; the mouse pad, however, takes up a chunk of your valuable desk space. Other users prefer the mechanical mouse to avoid the optical mouse pad; but the roller ball gets dirty and must be cleaned periodically.

A serial mouse or a bus mouse? All other things being equal, it depends on whether you can more easily spare a serial port or an expansion bus slot. The final decision usually comes down to whether you like the size, the style, the color, the length of the tail, the number of push buttons, and the price.

PC mice will continue to grow in popularity. Continuing evolution of the PC mouse will be in the area of ergonomics; I doubt resolution will push much beyond 400 ppi. Other pointing devices, especially trackballs, will gain some ground but the mouse is not likely to give away very much of its cheese. ■

Roger Alford is a computer design engineer and a freelance writer. He can be reached on BIX c/o "editors."

Your questions and comments are welcome. Write to: Editor, BYTE, One Phoenix Mill Lane, Peterborough, NH 03458.

MICROSOFT MOUSE DRIVER FUNCTION CALLS

Microsoft's mouse driver supports 35 functions, which provide a great deal of flexibility to the mouse programmer.

Function number	Description
0	Mouse Reset and Status
1	Show Cursor
2	Hide Cursor
3	Get Button Status and Mouse Position
4	Set Mouse Cursor Position
5	Get Button Press Information
6	Get Button Release Information
7	Set Minimum and Maximum Horizontal Cursor Position
8	Set Minimum and Maximum Vertical Cursor Position
9	Set Graphics Cursor Block
10	Set Text Cursor
11	Read Mouse Motion Counters
12	Set Interrupt Subroutine Call Mask and Address
13	Light Pen Emulation Mode On
14	Light Pen Emulation Mode Off
15	Set Mickey/Pixel Ratio
16	Conditional Off
—	
19	Set double-speed threshold
20	Swap interrupt subroutines
21	Get mouse driver state storage requirements
22	Save mouse driver state
23	Restore mouse driver state
24	Set alternate subroutine call mask and address
25	Get user alternate interrupt address
26	Set mouse sensitivity
27	Get mouse sensitivity
28	Set mouse interrupt rate
29	Set CRT page number
30	Get CRT page number
31	Disable mouse driver
32	Enable mouse driver
33	Software reset
34	Set languages for messages
35	Get language number
36	Get driver version, mouse type, and IRQ number



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PART 2

TALKING TASKS

A look at how OS/2 and Unix handle interprocess communications

This month, I will continue my tour of interprocess communications. So far, I have looked at the IPC facilities provided by Quarterdeck's Desqview and Microsoft's Windows. I'll now focus on OS/2 and Unix.

The fact that OS/2 and Unix appear in the same column is more or less an accident—but it's a happy one. As it turns out, remarkable similarities exist between the IPC facilities of both operating systems. The similarities appear at a high level—the implementations are quite different—but this lets me present the material in an overlapped fashion.

Pipes

In the wide array of IPC structures, the pipe is perhaps the simplest. It's a unidirectional communication path, usually leading from a parent process to one of its offspring processes, or vice versa. Data passes through a pipe in a purely unstructured form: a "stream" of bytes whose members come out the receiving end in the same order they were poured in at the sending end. Thus, the name *pipe* (see figure 1).

Since pipes are one-way streets, you usually acquire them in pairs.

OS/2 and Pipes

You create OS/2 pipes using the `DosMakePipe()` routine, which returns two handles: one for the read pipe, and the other for the write pipe. This looks strikingly similar to the Unix System V `pipe()` system call that I discuss later.

You'll notice I said that pipes are "usually" connected between a parent process and a child process. This is not so for named pipes, which can connect unrelated processes (see figure 2).

As their title suggests, you can attach identifying names to named pipes, and these names are accessible to other processes. The name you pick actually conforms to OS/2 filenaming conventions and has the form `\pipe\mypipe`, which specifies a pipe called "mypipe."

OS/2 named pipes operate in a client-server fashion: A server task creates the named pipe and awaits the connection of a client. An example is shown in the code fragments of listing 1, where the server builds a named pipe called "mypipe." The server task will wait at the `DosConnectNmPipe()` call until the client executes a `DosOpen()` on the named pipe. At that time, the connection is established, and the two tasks can communicate. (Once you create pipes, you can read and write to them as though they were files.)

In the example I've given, the server has created an inbound pipe, meaning that the client can only write to the pipe and the server can only read from it. Named pipes can be inbound, outbound, or duplex (i.e., bidirectional).

OS/2's named pipes enjoy another feature: They can be byte-wide or message-wide. A byte-wide pipe is a pipe in the strict sense; data is sent through the pipe as a byte-at-a-time stream. However, a message-wide pipe looks much like a message queue. You can send data in chunks of arbitrary size. (Interestingly, OS/2's `DosTransactNmPipe()` function lets you read *and* write data through a pipe at a single call. Of course, this works only if you open the pipe in duplex mode.)

The Pipes of Unix

You create a Unix System V pipe with a `pipe(descripts)` call, where `descripts` is a two-element integer array. The first member of the array is the file descriptor for reading the pipe; the second member is the file descriptor for writing the pipe.

Typically, you create a pipe between a parent process and a child process. The example most often given in Unix texts is

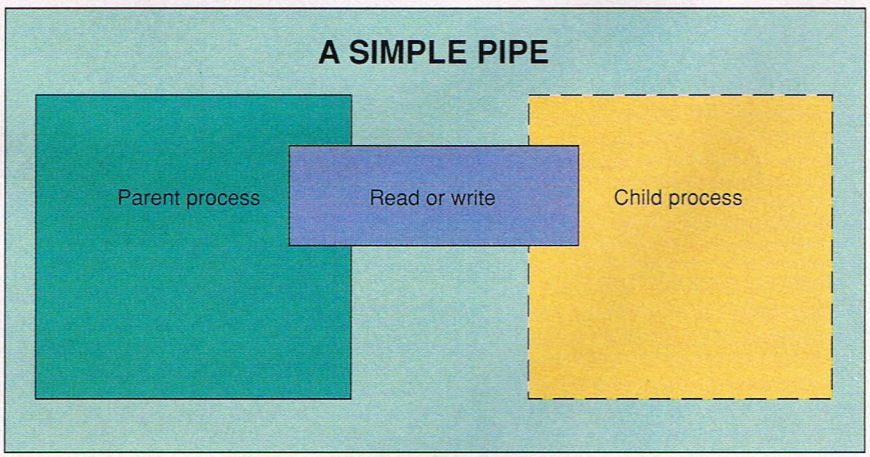


Figure 1: *A pipe provides a single read or write connection between a parent process and a child process. If you create a pipe for writing from the parent process, you must open it for reading from the child, and vice versa. Two-way communication requires two pipes.*

redirecting standard input through the pipe and executing a program. It looks something like what's shown in listing 2.

In listing 2, you simply point the character pointer variable `cmd` to some string holding the name of a command you want to execute, `grep` perhaps. The program issues a `fork()` system call, and the child process does the dirty work of redirecting the plumbing so that the parent task can write down the pipe, and the program launched by the `execl()` system call will see that data coming in through standard input.

Unix implements the equivalent of named pipes by using a special file type, FIFO, the acronym for first-in/first-out. Although FIFOs are not commonly used, they are the mechanism used by the Unix print spooler. Since a FIFO file is an entity of the Unix file system, it has owner, group, and world permissions and ownership as any other file. You need to pay special attention to ownership and permissions when you create a FIFO.

The function call looks like `mknod (pathname, mode, 0)`, where `pathname` is the name of the FIFO, and `mode` is the permissions ORed with the S_IFIFO flag (defined in `sys/stat.h`) to indicate that a FIFO is being created. (The `mknod` function is used for creating all the directories and file types in the file system.) Once you have a FIFO, you can open it for reading or writing with the same functions that are available for standard files.

Generally, FIFOs are opened only for reading by a daemon (background process), which uses whatever is poured in as its input. Then, as other processes need the facilities of the daemon, they send their data to it. The System V print spooler uses a FIFO to communicate between the user's `lp` processes and the system's printer daemon, `lpsched`. The FIFO also handles communications between other processes and the daemon. If each message is less than the capacity of the FIFO (i.e., 4096 bytes), it is guaranteed to be atomic; messages cannot mix. FIFOs provide a simple many-to-one IPC that does not require the processes to be related.

Listing 1: *Creating an OS/2 named pipe. The pipe is an inbound pipe, and it's byte-wide. I've reserved 512 bytes for the input buffer, and I'll specify a default wait of 500 milliseconds for the* `DosWaitNmPipe()`*—other tasks will use that function when trying to open this pipe.*

```
DosMakeNmPipe("pipe\\mypipe",&myphand,PIPE_ACCESS_INBOUND,
      PIPE_READMODE_BYTE | PIPE_TYPE_BYTE | PIPE_WAIT,
      0,512,500L);
/*
** Wait for a connection to this pipe.
*/
DosConnectNmPipe(&myphand);
/*
** Read from the pipe.
** Read 50 bytes into buff (which should be char *).
*/
Dosread(myphand,buff,50,&bytesred);
/*
** Close the pipe down.
*/
Dos DisConnectNmPipe(myphand);
DosClose(myphand);
```

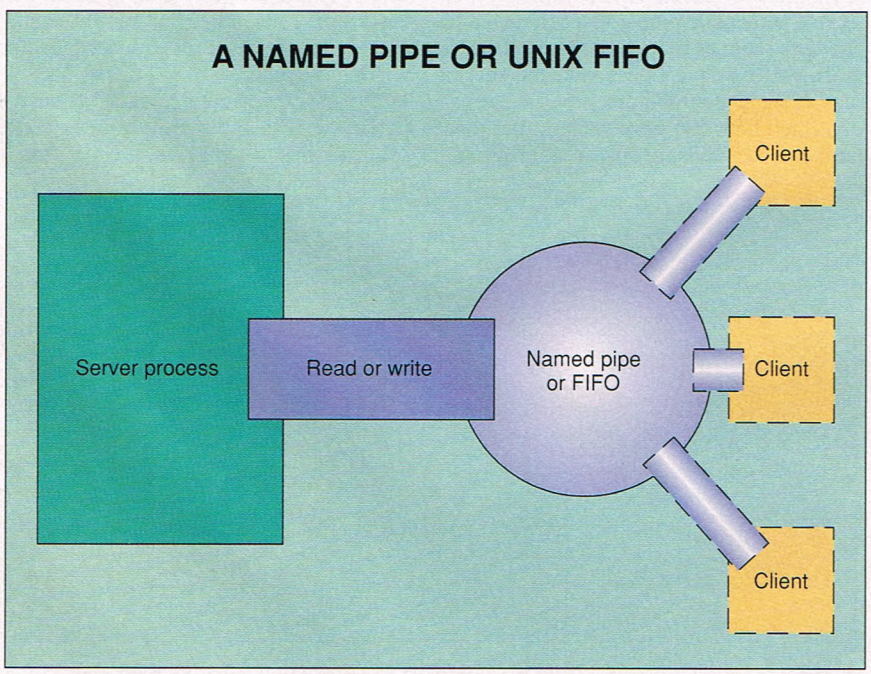


Figure 2: *Named pipes do not require a parent-child relationship between the communicating processes. The client processes can come and go independently from the server.*

Semaphores

Semaphores stand apart from the other IPC structures I've discussed. Unlike pipes, mailboxes, and such, it is not their job to pass data from one task to another. Rather, a semaphore exists to control access to a shared resource. It might be easier to think of a semaphore as a form of interprocess *coordination*, rather than interprocess *communication*.

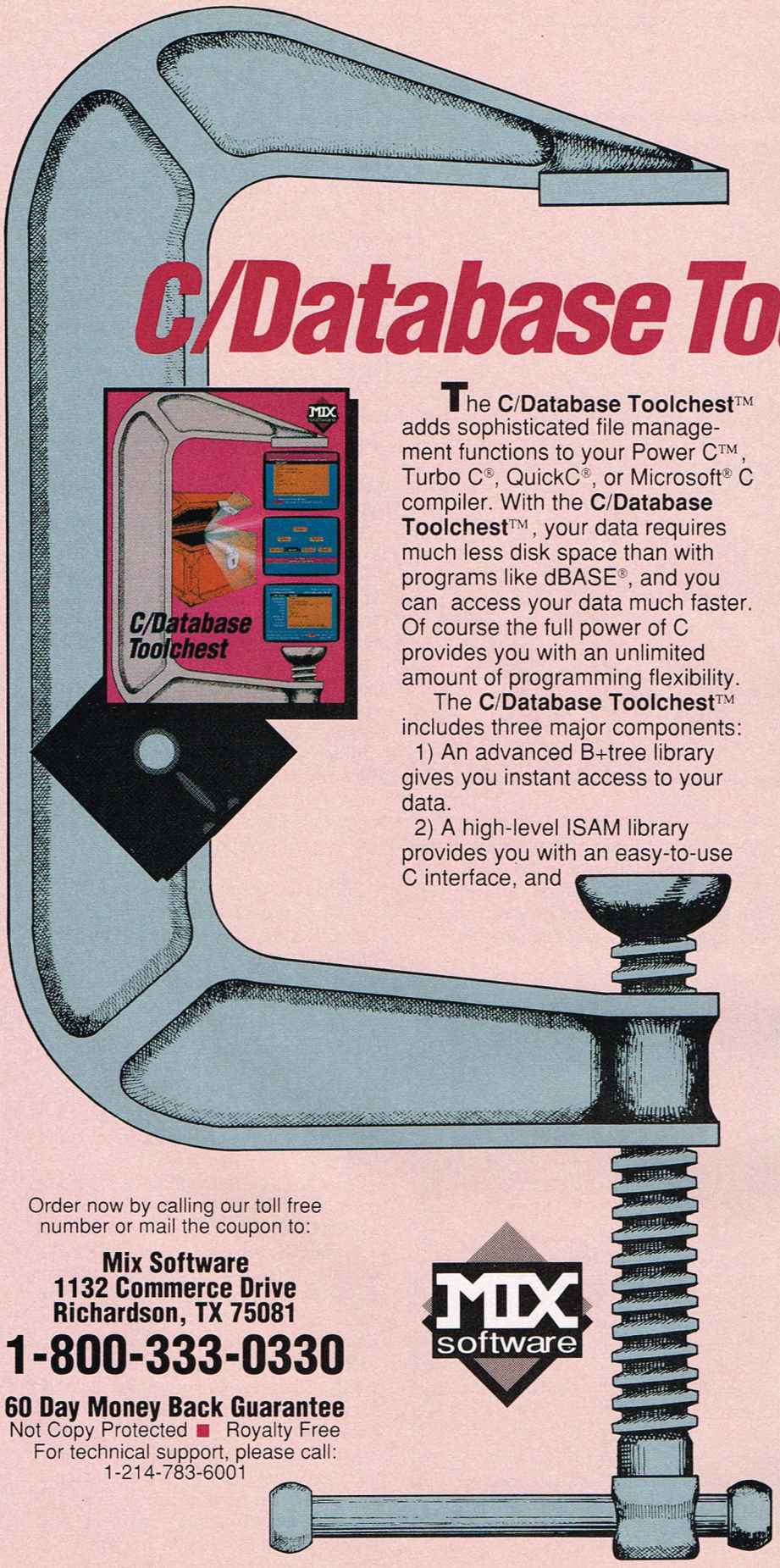
In essence, a semaphore is a variable. What makes it special is that your program performs *indivisible* operations on the variable. That is, while your program is accessing the semaphore variable, it is doing so exclusively (see figure 3).

For example, suppose that you have a printer server that—for reasons of memory constraint—manages a request queue that can hold no more than 10 filenames. If you build a semaphore to manage access to the queue, you would initialize the semaphore variable to a value of 10. Thereafter, whenever a client program wishes to send a request down the queue, the client first examines the value of the semaphore.

If the value is greater than zero, there is room in the queue and the client task proceeds to insert the request. The client then decrements the semaphore variable to indicate that the request has consumed a queue slot. If the client program sees that the semaphore is zero (indicating that the queue is full), the program either indicates the queue-full condition to an operator or waits for the semaphore to assume a nonzero value.

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Listing 2: *Creating a Unix pipe that writes to a child process.*

```
int pipedesc[2];
char *cmd;
/*
** Make a pipe. Return NULL if failure.
*/
if(pipe(pipedesc)==ERROR) return(NULL);
/*
** Fork a new process to execute program.
*/
if((pid=fork())==0)
{ /* Child process here */
  /* Close writing side of pipe */
  close(pipedesc[1]);
  /* Close standard input. */
  close(0);
  /* Dup read side-becomes standard input */
  dup(pipedesc[0]);
  /* Close old read side of pipe */
  close(pipedesc[0]);
  /* Execute the a program */
  execl("/bin/sh","sh","-c",cmd,0);
  exit(1);
}
/*
** Parent process here.
** Handle fork failure.
*/
if(pid==-1) return(NULL);
/*
** Close reading side of the pipe.
*/
close(pipedesc[0]);
/*
** Now, anything I write to pipedesc[1] will
** be passed to the program specified in cmd.
*/
```

As requests are taken off the queue, the server increments the semaphore to indicate that queue slots have become available. All these increments, decrements, and comparisons on the semaphore variable occur so that only one process has control of the semaphore at a time. This is critical in a multitasking system: While one process is examining the value of the semaphore variable, you can be sure that another process is not in the midst of modifying that variable.

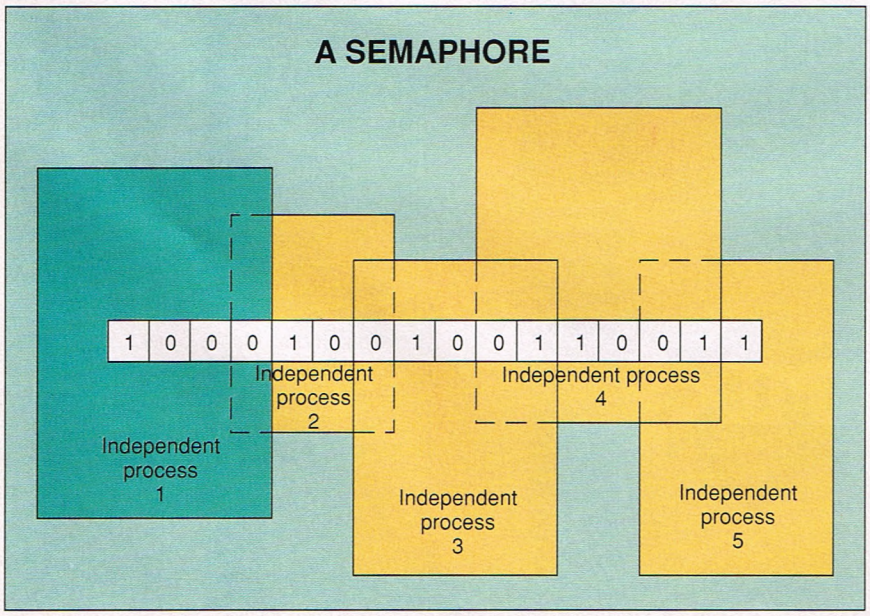


Figure 3: *A semaphore is a variable that is shared among processes. Only one process can act on the variable at a time. Thus, a semaphore is ideal for control of other forms of interprocess communications.*

OS/2 Semaphores

OS/2 provides several kinds of semaphores and a variety of supporting functions. System semaphores are named objects, as were the named pipes that I described earlier. Consequently, you create a system semaphore by specifying a name that conforms to the OS/2 filenaming convention, and the operating system returns a handle by which your program can reference that semaphore. For example, the following routine:

```
DosCreateSem(CSEM_PUBLIC,
 &semhand,''\\sem\\mysem'');
```

creates a public semaphore called "mysem."

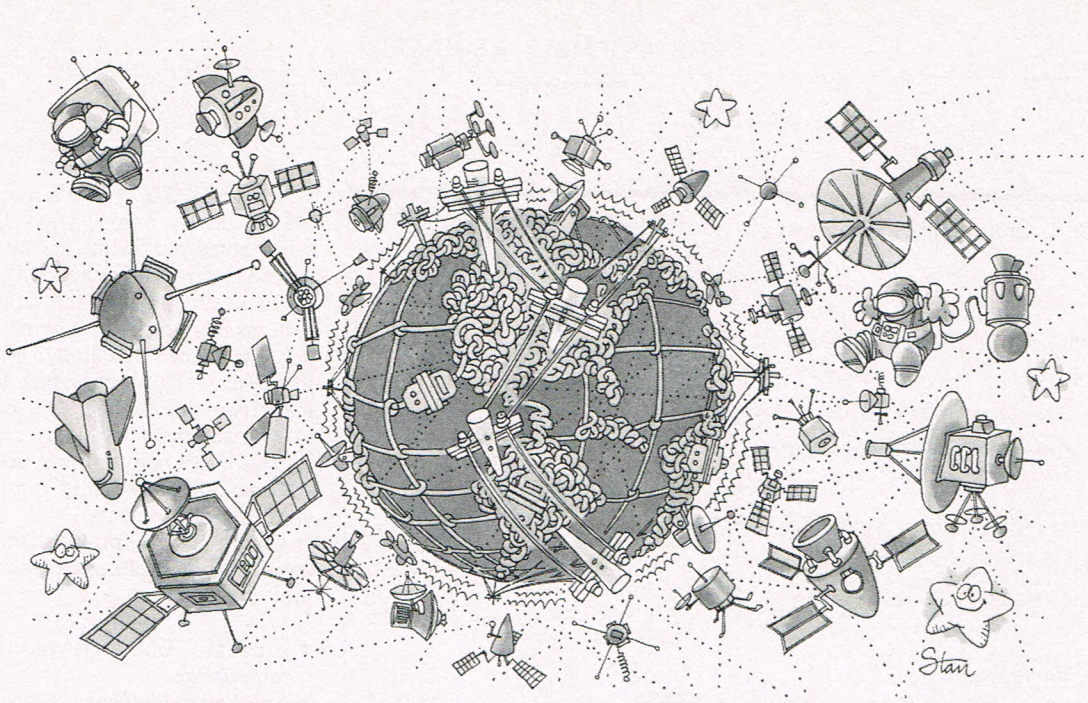
The first argument to the function is a system-defined constant that specifies that this particular semaphore's value can be modified by other tasks. (If I had created the semaphore with a first argument of `CSEM_PRIVATE`, the other tasks could only read the semaphore's contents.) OS/2 places the handle to this semaphore in the doubleword variable `semhand`. Another task in the system can gain access to this semaphore with the following call:

```
DosOpenSem(&semhand,
  ''\\sem\\mysem'');
```

Unlike a system semaphore, a RAM semaphore is not maintained by the OS/2 kernel. Rather, it is simply an unsigned long variable that you create as a global variable in the owning process. This presumes some discipline on your part: If you create a variable that is to become a RAM semaphore, you must manipulate that variable only through OS/2 semaphore functions. To do otherwise could violate the indivisibility of semaphore access and would surely result in flaky code.

Since a RAM semaphore is simply a global variable, processes don't need to call `DosCreateSem()` to construct them, or `DosOpenSem` to gain access to them. In fact, only threads local to the process can access the RAM semaphore, so a call to `DosOpenSem` makes no real sense in the context of a RAM semaphore.

OS/2 semaphores are binary semaphores: They are either set or cleared. You can create the effect of a multivalued semaphore (also known as a general semaphore)—as in the print-queue example I gave earlier—by constructing a semaphore that permits access to a variable in a shared-memory segment. (I'll discuss shared memory later.) The OS/2 routines for managing semaphores can



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Listing 3: *Creating an OS/2 semaphore.*

```
/*
** Instance of semaphore.
*/
struct sembuf unlock = {0,1,SEM_UNDO};
/*
** Create a semaphore with one member.
*/
if((mysem=semget(SEMKEY,1,IPC_CREAT|IPC_EXCL|WMODE))==ERROR)
{
      printf("**Cannot create semaphore\n");
      exit(0);
}
/*
** Unlock the resource controlled by the semaphore.
*/
if(semop(mysem,&unlock,1)==ERROR)
{
      printf("**Semaphore error\n");
      exit(0);
}
/*
** Release the semaphore.
*/
semctl(mysem,0,IPC_RMID);
```

operate on RAM semaphores as well as system semaphores.

To set a semaphore, you call `DosSemSet(mysem)`, where `mysem` is either a handle to a system semaphore or the address of a RAM semaphore. You clear a semaphore with the call `DosSemClear(mysem)`. Finally, your program can wait for a specified semaphore to be cleared by calling `DosSemWait(mysem)`.

However, to securely manage a resource, the operations of waiting on the semaphore to clear and immediately setting it must occur without interruption (as I described above). You can accomplish this with the call `DosSemRequest(mysem,ltime)`, where `mysem` references a semaphore as before, and `ltime` is a doubleword specifying a millisecond time-out value.

`DosSemRequest()` will wait for the indicated semaphore to clear or until the time given in `ltime` has elapsed. If the semaphore clears, `DosSemRequest()` immediately sets the semaphore and returns to the caller. If `DosSemRequest()` times out, it returns a value that is an error code indicating the time-out condition.

Finally, if you've got a number of semaphores riding herd on various events and you want to monitor them as a group, you can use `DosMuxSemWait()`. This routine accepts an array of semaphore handles and waits for *any* member of the set to clear.

Unix Semaphores

Under Unix System V, you can create groups of semaphores—referred to as a semaphore set—with one call. Also, Unix semaphores can be multivalued, and the operating system provides a complex array of semaphore operations (i.e., the operations go beyond simply setting or clearing the semaphore).

Whereas OS/2 system semaphores are identified by name, Unix System V semaphores are identified by a unique number referred to as a facility key. This key is of type `key_t`, and on most Unix systems it is simply a 32-bit number. The key acts as the semaphore's system-wide identifier—any process that knows the identifier can access the semaphore. (You'll see the facility key cropping up several times before this article is done. It is roughly the Unix equivalent of OS/2's named objects.)

Unix System V provides three system calls for manipulating semaphores. They are:

- `semget()`, which lets you create semaphores;
- `semop()`, which lets you operate on semaphores; and
- `semctl()`, which provides a number of service functions for examining and modifying a semaphore's status.

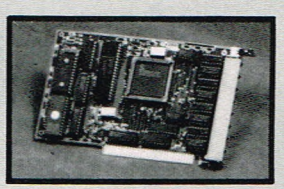
You can also use `semctl()` to delete the semaphore.

I've provided some code fragments highlighting usage of semaphores in listing 3. The call to `semget()` creates a semaphore with an identifying key set by the constant `SEMKEY` and containing one member (the number of semaphores in the set is determined by the second argument). The third argument to `semget()` is a flags word that (in the example given) tells the system to create the semaphore if it doesn't already exist; if it does, return an error condition.

The `semop()` call also takes three arguments. The first is the semaphore's identifying key, the second is the pointer to an array of semaphore operation structures, and the third is the number of entries in that array. Since Unix System V

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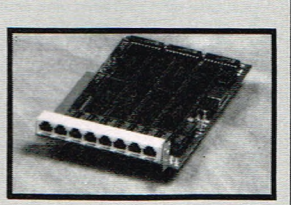


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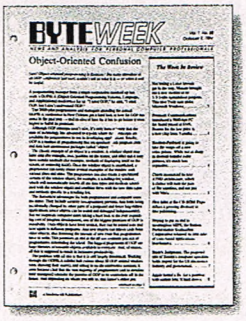
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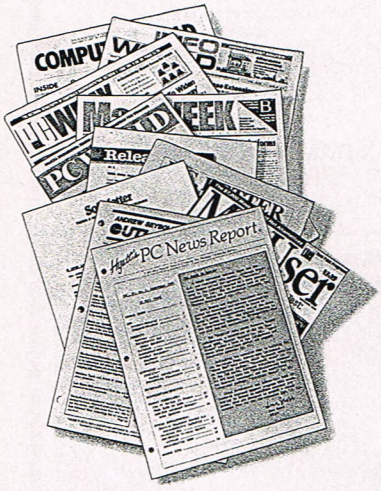
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lets you create sets of semaphores with one call (and identified by a single key), having the ability to pass in multiple operations per the semop() call is a real time and space saver.

In listing 3, the array consists of only one member, and you can see its definition near the beginning of the listing as structure unlock. The first element of the semaphore operation structure array member (whew!) specifies the member of the semaphore set with which this particular operation is concerned—zero in the example, since there's only one member of the semaphore set. The second element specifies the operation itself: In listing 3, this operation value is 1, which tells the system to increment the

Listing 4: *OS/2 shared memory.*

```
/* Selector for shared segment */
SEL myselect;
/*
** See if shared segment exists.
** Create it if it doesn't.
*/
while(1)
if(DosGetShrSeg("\\sharemem\\myshrseg",&myselect)
 == ERROR_FILE_NOT_FOUND)
{
       if(DosAllocShrSeg(1000,"sharemem//myshrseg",&myselect)==0)
            break;
}
else
        break;
}
/*
** Free the shared segment.
*/
DosFreeSeg(myselect);
```

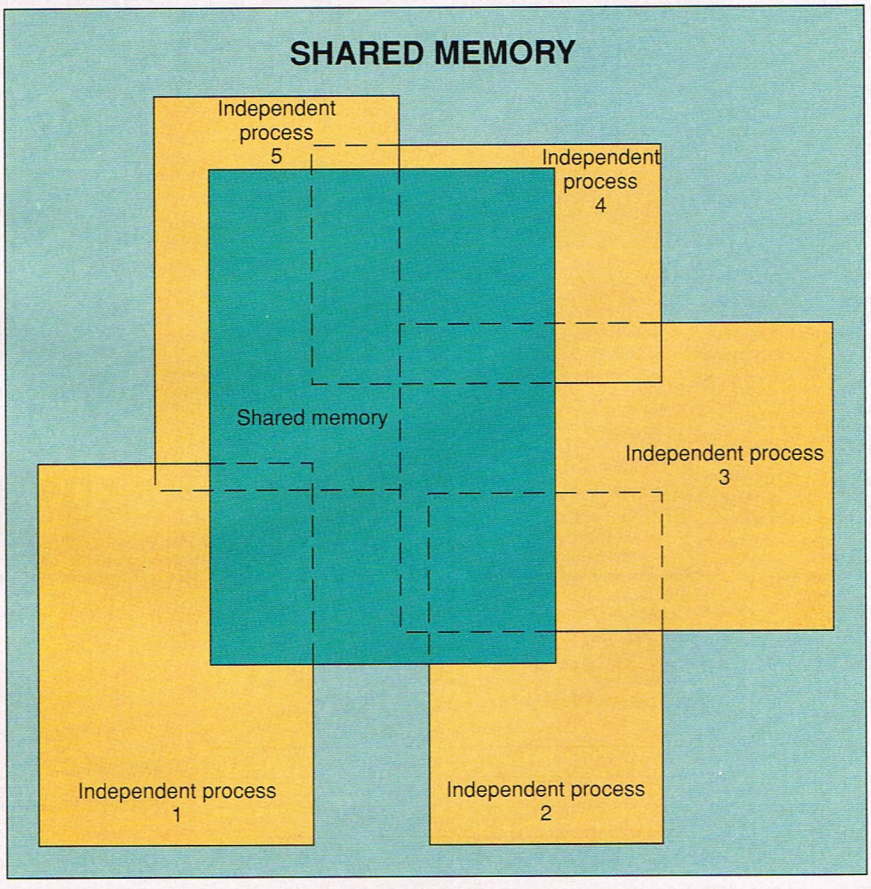


Figure 4: *A region of memory that is shared among participating processes.*

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semaphore by 1. The third element carries a number of flags.

The example in listing 3 tells the system to increment a system variable by the amount that the operating system associates with the semaphore and the process. In this way, if the process dies unexpectedly, Unix knows by what amount to readjust the semaphore so that other processes waiting on the semaphore will not be stranded forever.

Finally, the program calls `semctl()` to release the semaphore. I should point out that you can use `semctl()` to do much more than I've shown in listing 3. For example, you can determine the process ID of the last process to perform an operation on the semaphore set, you can determine how many processes are currently waiting for the value of a particular semaphore to become greater than its present value, and more.

Shared Memory

In structure, shared memory is perhaps the simplest of IPCs. Shared memory is just that—a region of memory shared among the participating processes.

This makes shared memory the fastest form of IPC; data doesn't really move from one place to another. Data written into the shared memory by one process is "instantly" available to all the processes enjoying access to that memory (see figure 4).

OS/2 Shared Memory

OS/2 serves up shared memory in two flavors: global and local. (Because of the nature of the host processor, OS/2 documentation typically refers to shared memory as *shared segments*. So that I won't have to bog you down with *shared-memory segments*, I'll simply use *shared segments* for the rest of this section.) When you create a global shared segment, you attach a name to it (as in named pipes and sempahores). Thereafter, any process that knows the name of the segment can also access it.

Listing 4 shows a fragment of code in which a process first looks for a global shared segment and then—if the segment is not found—creates the segment.

The code in listing 4 appears convoluted, thanks to the nature of manipulating shared objects in a multitasking environment. If the call to `DosGetShrSeg()` fails because the segment does not exist (ERROR_FILE_NOT_FOUND), the `if` statement falls through to execute `DosAllocShrSeg()`, which actually creates the shared segment.

However, between the return of `DosGetShrSeg()` and the execution of `Dos-`

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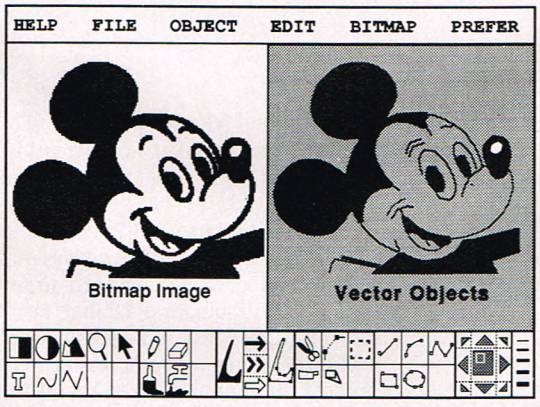
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Listing 5: *Unix shared memory.*

```
int shmid; /* Shared memory identifier */
char *shmloc; /* Address where shared memory is mapped */
/*
** Create a 1K-byte shared memory segment.
*/
shmid=shmget(SHMKEY,1024,IPC_CREAT | IPC_EXCL | WMODE);
/*
** Attach it to our memory space.
** A second argument of 0 means we'll let Unix decide where to
** map the block.
** We can access the memory through pointer variable shmloc.
*/
shmloc=shmat(shmid,(char *)0,0);
/*
** Detach the shared memory block and release it.
*/
shmdt(shmloc);
shmctl(shmid,IPC_RMID);
```

AllocShrSeg(), there is a small chance that another process might be switched in by OS/2 and create the shared segment. If that happens, when the program of listing 4 resumes, the DosAllocShrSeg() will fail with an ERROR_ALREADY_EXISTS return code. Hence, the while loop, which reattempts the DosGetShrSeg() call and solves the problem.

OS/2's local shared segments are designed to be more secure than global shared segments. You don't reference the segment by name; you reference it by a segment selector. Since no globally accessible name is available for the segment, the process creating the shared segment can control which other processes have access to the segment.

For example, I can create a local shared segment of 1000 bytes with a call to the following:

```
DosAllocSeg(1000,&mysel,
  SEG_GIVEABLE);
```

where mysel will hold the selector to the created segment. Of course, the segment doesn't become shared until I give it away.

To do this, I have to build a selector that the other process can use to access the segment. I do this with the following:

```
DosGiveSeg(mysel,hisid,
  &hissel)
```

where hisid is the ID of the process to which I want to allow access to the segment. Upon return, the variable hissel holds the selector that I can now pass to the process identified by hisid. (Ironically, I would have to construct some other form of IPC [e.g., a named message queue or global shared segment] to pass the selector to the other process.)

The above example isn't the only way to manage local shared segments. I chose to allocate the segment with attribute SEG_GIVEABLE, which means it's my job to create the selectors that get passed to other tasks.

I could have created the segment with attribute SEG_GETTABLE, in which case I would pass other processes a copy of my selector, and it would be their job to convert that selector to one they could use (via a call to DosGetSeg()).

OS/2's local shared segments are more secure than global shared segments.

Unix Shared Memory

Unix System V makes no distinction between local and global shared memory (as in OS/2).

If I were to use OS/2 terminology, shared memory in Unix is always global. When you create a shared-memory block, you associate a facility key that has the same form as I described in the section on Unix semaphores. Any other process that knows the key can attach itself to the shared-memory block.

You use the shmget() call to create a shared-memory block. If shmget() completes successfully, it returns an integer handle to the shared memory.

Your program then passes this handle to the shmat() function, which "attaches" the memory block to your program and returns a pointer to the starting address of the shared-memory block. Your program can read and write into the memory block as it would any other memory region.

At its completion, your program "detaches" the shared-memory block using a call to shmdt(). This call doesn't actually destroy the shared-memory block; it simply removes the caller's ability to access the memory. You have to call the shmctl() routine to free the memory. Typically, the task that built the shared-memory block in the first place will be the one to remove it.

I've given an example of creating and using a shared-memory block in listing 5. The listing is very brief. Usually, you will want to associate a semaphore with a shared-memory block and use the semaphore to coordinate access to the memory.

As with the semaphores, Unix associates a structure with every shared-memory block that the tasks create. This structure carries information regarding the shared-memory segment (e.g., the ID of the process that created the shared-memory block and the current number of attached processes). Although in the example in listing 5 I've used shmctl() only to release the shared-memory structure, you can use that function to manipulate information in the structure that Unix associates with the shared-memory block.

Message Queues

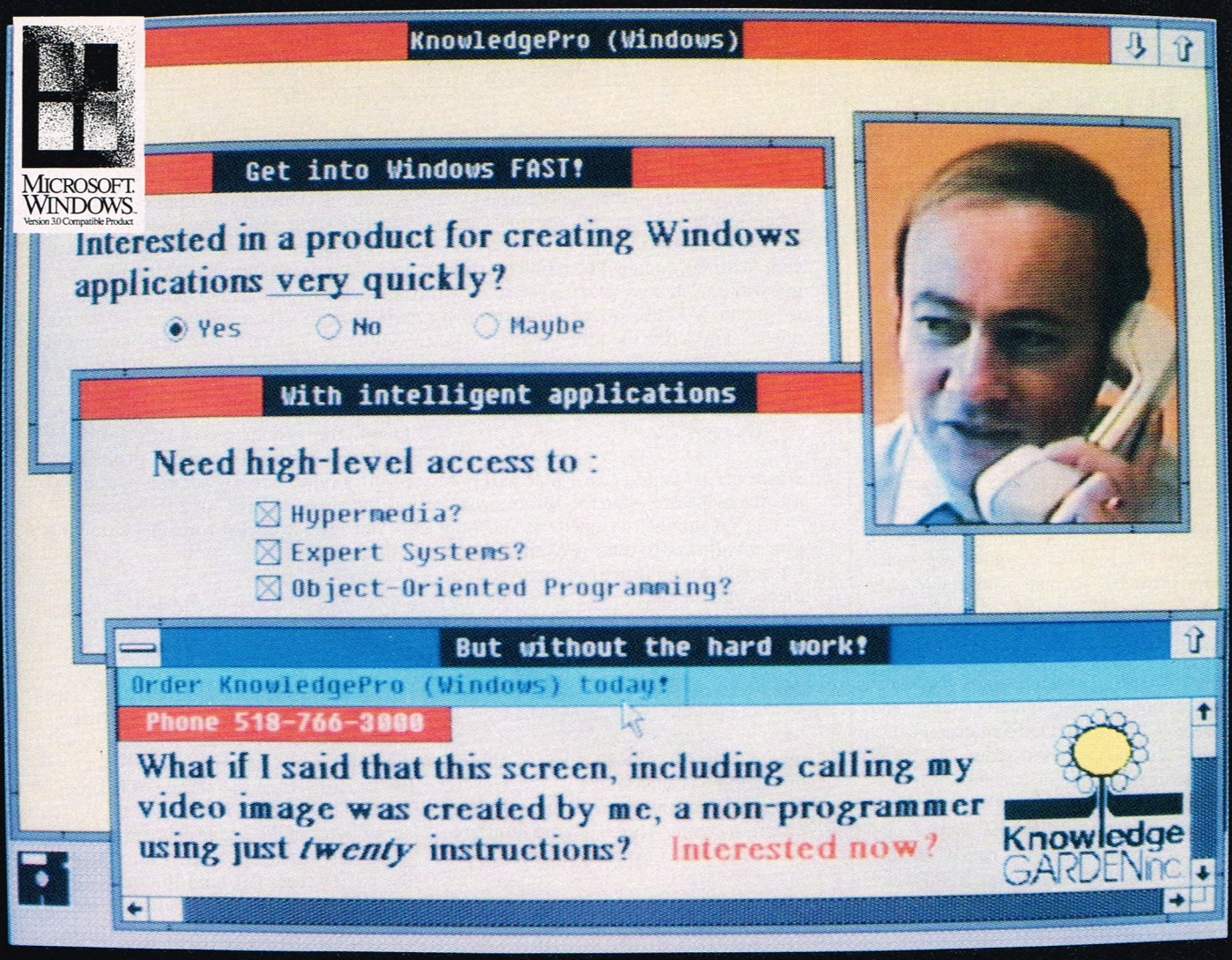
Actually, I have already given a cursory description of message queues. They first appeared last month when I talked about Desqview's mailboxes. Also, in OS/2, named pipes can do much of the work of message queues.

The message queue derives its name from its FIFO characteristics. Usually, however, operating systems provide ways to let important messages "cut in" the queue ahead of current members.

OS/2 Queues

OS/2 queues are not restricted to FIFO ordering of elements. When you create a queue, you can select the ordering to be one of the following:

- FIFO—which is a typical queue (see figure 5a)
- last-in/first-out (LIFO)—which causes the queue to behave like a stack (see figure 5b)
- element priority—The sending process can attach a priority to each message item. When the receiving process requests OS/2 to pull the next item off the queue, the operating system will select the item with the highest priority first.



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As with other named items, when you create a message queue, you must give OS/2 a unique file-type name to associate with the queue. The name must begin with the string \\queues\\, so a call to create a FIFO queue named "myqueue" looks like the following:

```
DosCreateQueue(&qhand,
  QUE_FIFO,''\\queues
 \\myqueue'');
```

where qhand is a variable that will hold the queue handle when the call returns.

The creator of the queue is the only process allowed to remove elements from the queue. Other processes can write elements into the queue, but before they do, they must open the queue with the following call:

```
DosOpenQueue(&qowner,&qhand,
  ''\\queues\\myqueue'')
```

where qhand is the handle (as above), and qowner is a variable that receives the process ID of the queue's creator. Your program can then issue a write request to the queue with something like the following:

```
DosWriteQueue(qhand,rqid,8,
  ''A Message'',priority);
```

The first argument is the handle. The second is a program-supplied request/identification field that your programs can use to support any sort of private protocol you dream up. The third argument is, obviously, the length of the message—a pointer to which follows as the fourth argument. The fifth and final argument is the priority, which can range from 0 to 15 (highest priority) and sets the message's element priority. As you might guess, the system recognizes the final argument only if the queue is an element-priority type. Otherwise, you read items off the queue in FIFO or LIFO order.

You read a queue with the following call:

```
DosReadQueue(qhand,&reqinf,
  &size,&qelement,0,DCWW_WAIT,
  &priority,NULL);
```

which has a boatload of arguments. The first is the queue handle; that's easy. Next comes a structure that carries results of the read request (information like the process ID of the source of the message). The size variable holds the number of bytes of the queue element the program has just read. Next is a pointer to the buffer that will hold the queue element. The next argument indicates which member of the queue you want retrieved—for the standard FIFO queue, the argument is ignored, so I've set it to zero. I used DCWW_WAIT to tell OS/2 that I

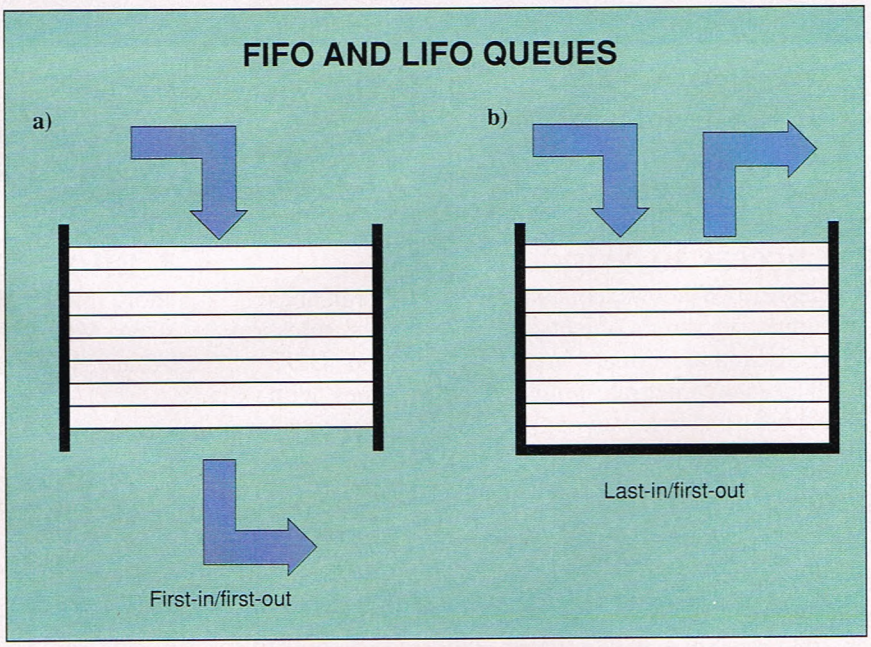


Figure 5: (a) *As with a pipe, the first data written to a first-in/first-out message queue is the first data read out by another process.* **(b)** *The last-in/first-out message queue is like a stack; the last data written to a LIFO message queue is the first data to be read.*

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want to wait for an item to appear on the queue (if it's empty).

The `priority` variable carries the element's priority that was set by the sender in `DosWriteQueue()`. The last argument usually carries a system semaphore handle that can control access to the queue. However, it's ignored because I chose `DCWW_WAIT`.

As a final tidbit, there often comes a time when you want to see what's on the queue without actually taking anything off it. You can use `DosPeedQueue()` for the job.

Unix Queues

In Unix, the creation and manipulation of message queues looks a lot like what I've already described in the sections on semaphores and shared memory. Message queues are identified by a facility key that is available systemwide.

By now, you've probably become familiar enough with the Unix conventions for working with IPCs that I won't have to go into much detail. You create a message queue with a call to `msgget()`; you release the queue by calling `msgctl()`. As with `semctl()` and `shmctl()`, `msgctl()` provides access to system-maintained status information associated with the queue. You can use `msgctl()` to determine such information as who created the queue, how many messages are on the queue, who last wrote to it, and who last read from it. (OS/2 has a counterpart to this routine in its `DosQueryQueue()` system call.)

Items sent through the queue are two-member structures. The first member is a `long` variable that identifies the message type. Ordinarily, Unix doesn't pay attention to this field, so your program can make whatever use of it you deem appropriate.

You can use the message type field to impose ordering on the items in a queue.

However, a process reading items from a queue can request the operating system to return the first item whose message type field is set to a particular value. So you can use the message type field to impose ordering on the items in a queue.

An example would be to designate a particular message type as being an "immediate attention" message. In that way, any process reading from the queue could check for such messages and handle their requests first.

The second member is simply an arbitrarily long array of characters. Your program can impose any structure on a message element it wishes.

The operating system doesn't care—it just treats them as a string of bytes. You send a message using the `msgsnd()` routine and receive a message using the `msgrcv()` routine.

On the Menu

The source code for this month is a good illustration of Unix semaphores and message queues. (The source code is available through the usual sources; see page 5 for details.) It is the database simulation portion of BYTE's Unix benchmark programs and is composed of two source code files. One is a server program that builds a pair of message queues and a controlling semaphore. The program then launches a number of client processes (using the Unix `fork()` routine). The client processes begin making random database requests (i.e., read a record, write a record, or update a record) to the server.

One message queue acts as the client-request channel; the other is the server-response channel. When a client sends a request message, the program places its process ID in the message type field (described above). The process ID stays with the request, so the server's responding message also carries the process ID in the message type field. Consequently, even though several clients are reading from the same queue, each can extract the appropriate response. ■

Rick Grehan is the director of the BYTE Lab. He has a B.S. in physics and applied mathematics and an M.S. in computer science/mathematics from Memphis State University. He can be reached on BIX as "rick_g."

Your questions and comments are welcome. Write to: Editor, BYTE, One Phoenix Mill Lane, Peterborough, NH 03458.



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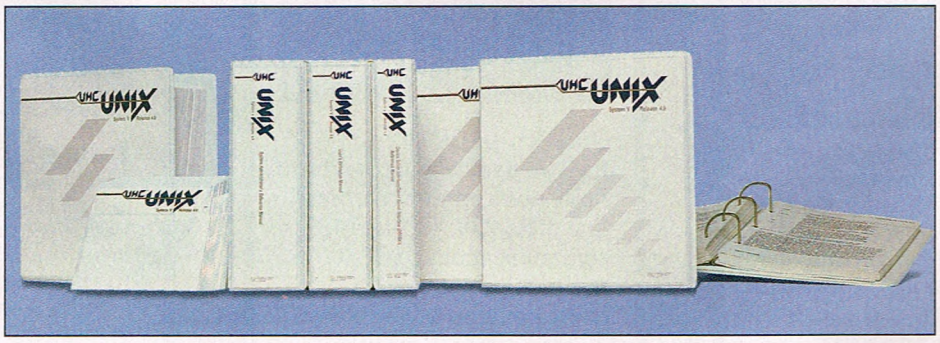
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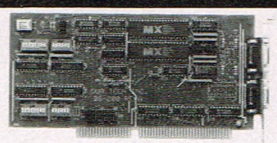
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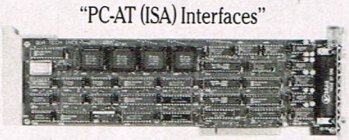
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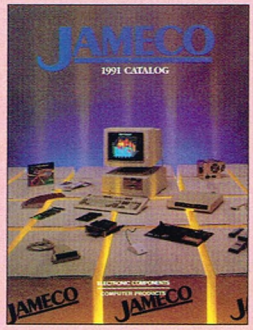
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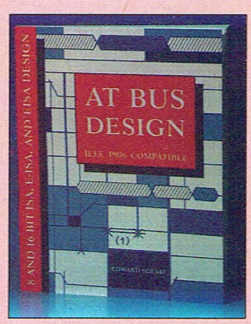


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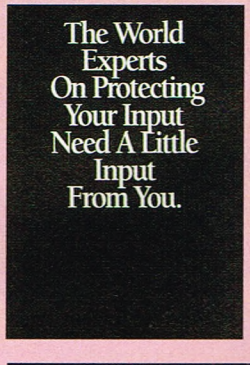
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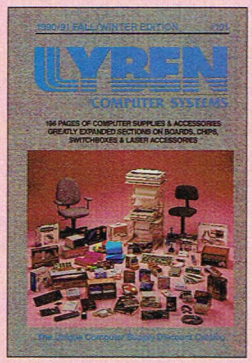
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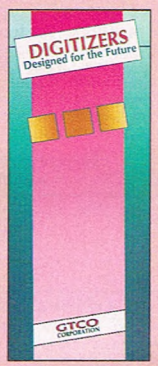
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THE BUYER'S MART is a monthly advertising section which enables readers to easily locate suppliers by product category. As a unique feature, each BUYER'S MART ad includes a Reader Service number to assist interested readers in requesting information from participating advertisers.

Effective January 1, 1990.

RATES: 1x—$590 3x—$550 6x—$525 12x—$475 24x—$450
Prepayment must accompany each insertion. VISA/MC Accepted.

AD FORMAT: Each ad will be designed and typeset by BYTE. Advertisers must furnish typewritten copy. Ads can include headline (23 characters maximum), descriptive text (250 characters is recommended, but up to 350 characters can be accommodated), plus company name, address and telephone number. Do not send logos or camera-ready artwork.

DEADLINE: Ad copy is due approximately 2 months prior to issue date. For example: November issue closes on September 8. Send your copy and payment to THE BUYER'S MART, BYTE Magazine, 1 Phoenix Mill Lane, Peterborough, NH 03458. For more information call Brian Higgins at 603-924-3754.

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Inquiry 701.

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Inquiry 705.

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FOR 386, 286 & PC

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XT HD/DD FD Controller	$ 32	AT HD/FD Card MFM/RLL	$89/119
XT I/O (F/S/P/G/C)	$ 29	AT I/O (S/P/G), 1S/2S	$19/25
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(800) 638-4833

Inquiry 707.

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(214) 234-2611 **Fax (214) 234-2674**
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THE BUYER'S MART

BAR CODE

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Inquiry 715.

BAR CODE

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E...easy to use, **N**...nationally listed by USPS, **V**...value packed **ENV** bar coded envelopes are quickly sorted and delivered by the US Post Office. Postage discounted when over 200 bar coded pieces. • Use with any Word Processor or Mail Merge package • ENV Batch, Popup and Mail Merge versions on disk • Print return address, special messages and logos • for HP LaserJets and EPSON LQ series printers. No new equipment required. Great program for any type and size business, church, club or association. Order for MSDOS computers NOW $49.95

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(603) 595-0420

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THE BUYER'S MART

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Inquiry 734.

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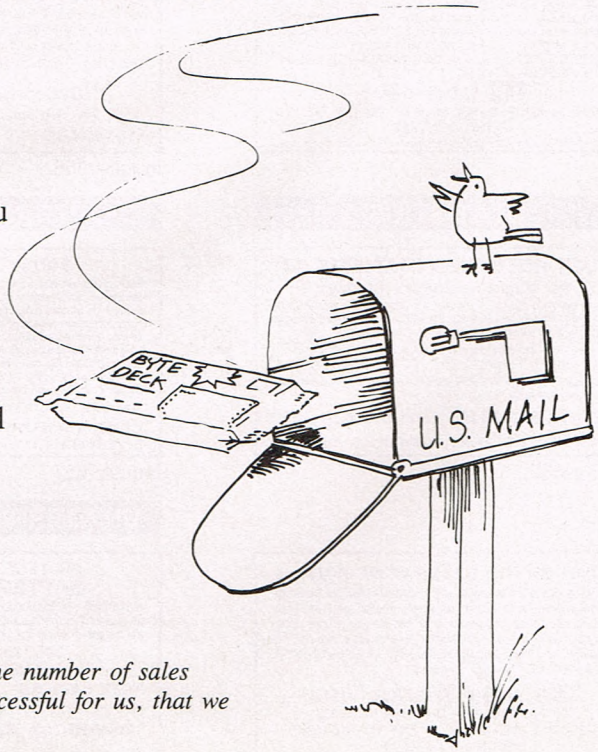
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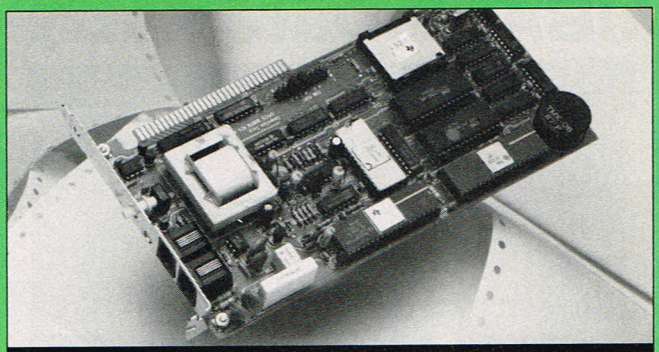
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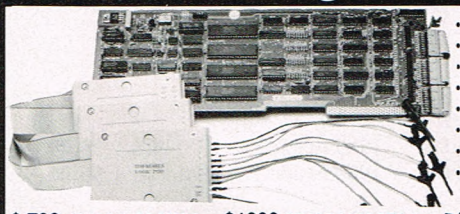
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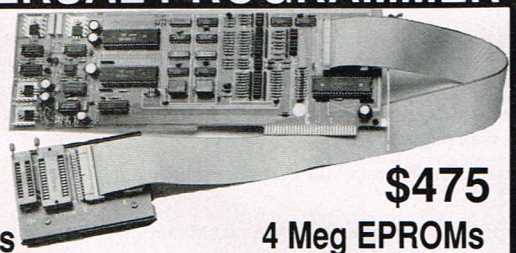


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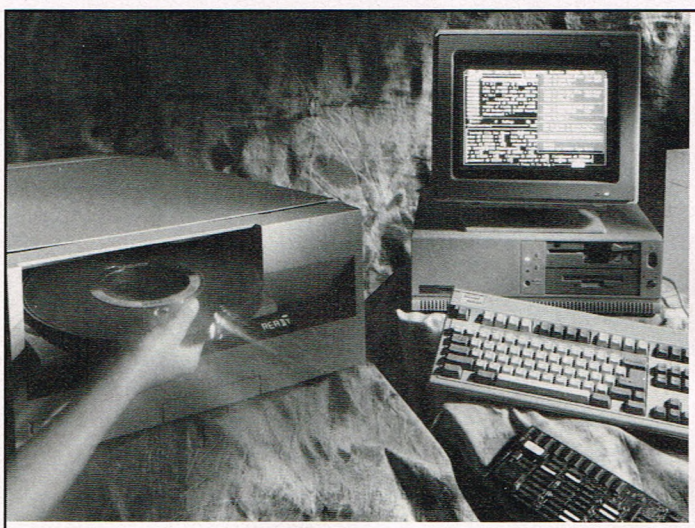
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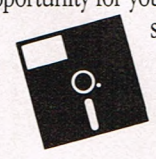
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A-BUS™ NEWS

New Products

Alpha Products proudly announces two new product lines: **C·Net** serial communications devices, and **Alpha Box** interfaces. These new products are not merely A·Bus accessories, but complete sets of products for all of your interfacing needs.

All the products are used to connect different types of devices to your computer. Our communications devices help you connect devices that have computer interfaces already built in. **C·Net** provides the option of connecting many different RS-232 devices to a single serial port on your computer. We also carry converters to other standards, including RS-422, RS-485 and IEEE-488.

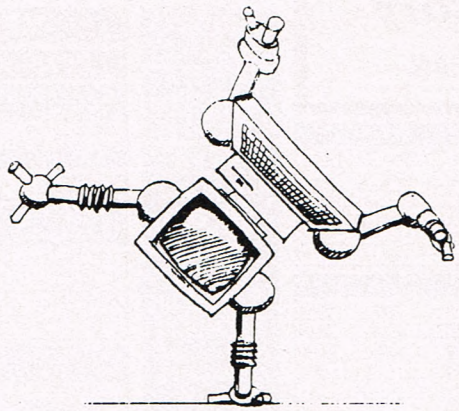
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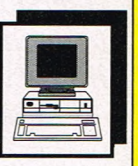
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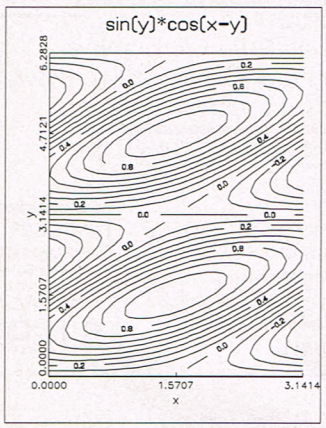
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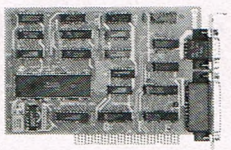


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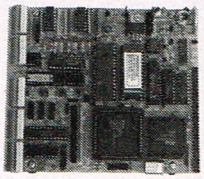
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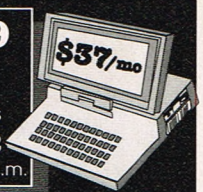
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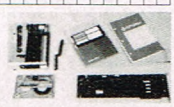
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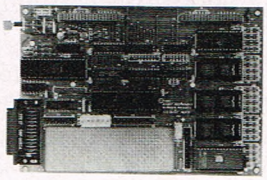
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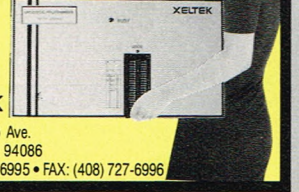
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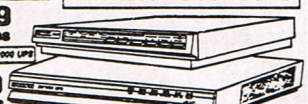
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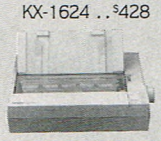
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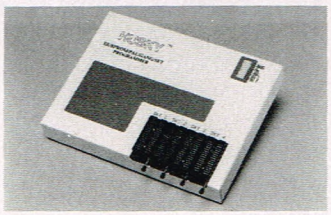
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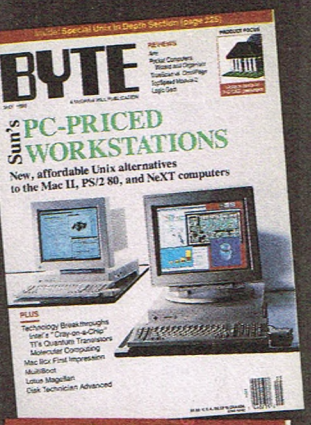
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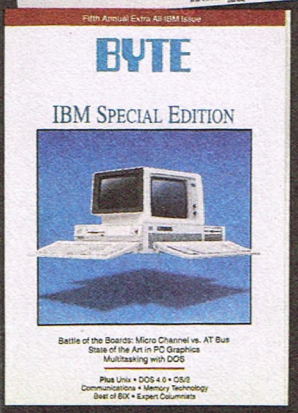
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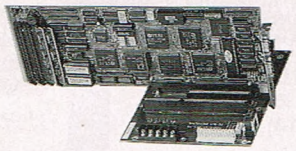
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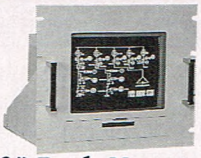
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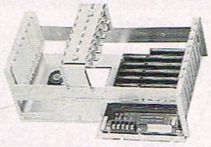
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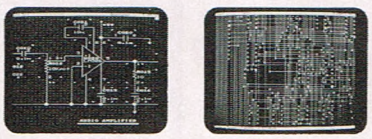
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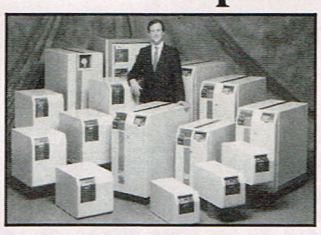
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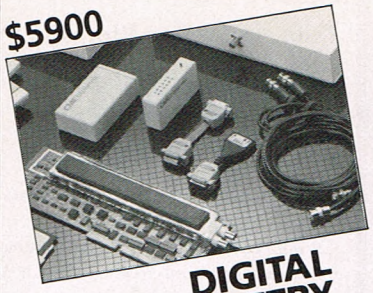
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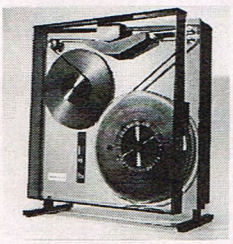
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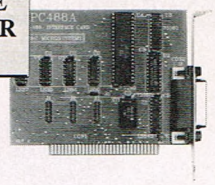
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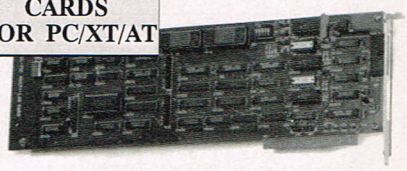
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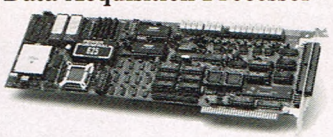
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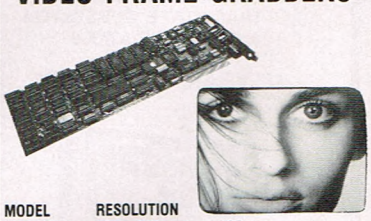
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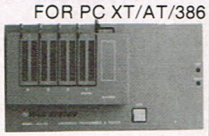
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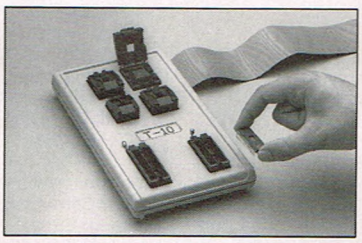
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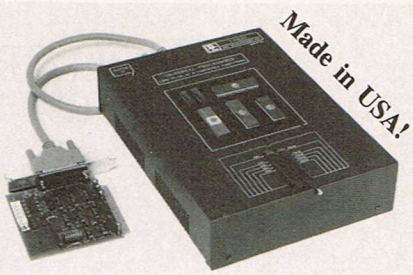


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1464	1465	1466	1467	1468	1469	1470	1471	1472	1473	147
1475	1476	1477	1478	1479						

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2 Check all the appropriate answers to questions "A" through "E".

3 Print your name and address and mail.

Fill out this coupon carefully. PLEASE PRINT.

Name _____

Title _____ ( ) Phone _____

Company _____

Address _____

City _____ State _____ Zip _____

A. What is your primary job function/principal area of responsibility? (Check one.)

1 ☐ MIS/DP
2 ☐ Programmer/Systems Analyst
3 ☐ Administration/Management
4 ☐ Sales/Marketing
5 ☐ Engineer/Scientist
6 ☐ Other

B. What is your level of management responsibility?

7 ☐ Senior-level 9 ☐ Professional
8 ☐ Middle-level

C. Are you a reseller (VAR, VAD, Dealer, Consultant)?

10 ☐ Yes 11 ☐ No

D. What operating systems are you currently using? (Check all that apply.)

12 ☐ PC/MS-DOS 15 ☐ UNIX
13 ☐ DOS + Windows 16 ☐ MacOS
14 ☐ OS/2 17 ☐ VAX/VMS

E. For how many people do you *influence* the purchase of hardware or software?

18 ☐ 1–25 20 ☐ 51–99
19 ☐ 26–50 21 ☐ 100 or more

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NOVEMBER
IRSC004

Inquiry Numbers 1-493

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Inquiry Numbers 494-986

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Inquiry Numbers 987-1479

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Company

Address

City State Zip

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1 ☐ MIS/DP
2 ☐ Programmer/Systems Analyst
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4 ☐ Sales/Marketing
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6 ☐ Other

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NOVEMBER
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Inquiry Numbers 1-493

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Inquiry Numbers 494-986

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Inquiry Numbers 987-1479

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1361	1362	1363	1364	1365	1366	1367	1368	1369	1370	1371	1372	1373	1374	1375	1376	1377
1378	1379	1380	1381	1382	1383	1384	1385	1386	1387	1388	1389	1390	1391	1392	1393	1394
1395	1396	1397	1398	1399	1400	1401	1402	1403	1404	1405	1406	1407	1408	1409	1410	1411
1412	1413	1414	1415	1416	1417	1418	1419	1420	1421	1422	1423	1424	1425	1426	1427	1428
1429	1430	1431	1432	1433	1434	1435	1436	1437	1438	1439	1440	1441	1442	1443	1444	1445
1446	1447	1448	1449	1450	1451	1452	1453	1454	1455	1456	1457	1458	1459	1460	1461	1462
1463	1464	1465	1466	1467	1468	1469	1470	1471	1472	1473	1474	1475	1476	1477	1478	1479

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4164-120	65536x1	120ns	16	2.89
4164-100	65536x1	100ns	16	3.39
TMS4464-12	65536x4	120ns	16	3.95
41256-150	262144x1	150ns	16	2.59
41256-120	262144x1	120ns	16	2.95
41256-100	262144x1	100ns	16	3.15
41256-80	262144x1	80ns	16	3.75
414256-100	262144x4	100ns	20	12.95
414256-80	262144x4	80ns	20	13.45
1MB-120	1048576x1	120ns	18	11.95
1MB-100	1048576x1	100ns	18	12.35
1MB-80	1048576x1	80ns	18	12.95
1MB-70	1048576x1	70ns	18	13.95

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421000A8B-10	1MB x 8	100ns	SIMM/MAC	109.95
421000A9B-10	1MB x 9	100ns	SIMM/PC	113.95
421000A9B-80	1MB x 9	80ns	SIMM/PC	119.95
421000A9B-60	1MB x 9	60ns	SIMM/PC	149.95
256K9SIP-80	256K X 9	80ns	SIP/PC	54.95
256K9SIP-60	256K X 9	60ns	SIP/PC	64.95
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1MBx9SIP-80	1MB x 9	80ns	SIP/PC	124.95

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80387-SX20	20 MHz	399.95
80387-16	16 MHz	359.95
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Derick's HIGH-TECH SPOTLIGHT

MODEM STANDARDS

I now feel comfortable publicly recommending CCITT V.32 and MNP communications protocols!

CCITT V.32 is a description of the electrical signals used over phone lines to move data. The CCITT is an international committee that refines the input from many modem industry experts into one accepted standard. Sometimes users or industry experts reject the efforts of standards committees and follow a single industry leader (as was the case with the IBM PC). Here, the committee prevailed.

The Microcom Network Protocol (MNP) is the product of 1 company's efforts to fix data errors and improve transmission efficiency. They've made their protocol available to others for a fee, and have been accepted by users en mass. The committee approach has not worked well in this area.

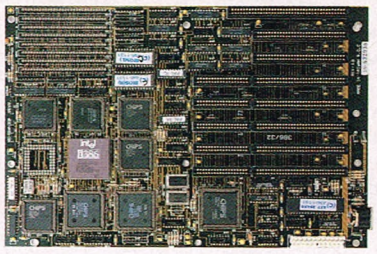
MNP-5 is an implementation of the protocol that insures reliable data transfer and compresses data at a rate of about 2 to 1. Thus, a modem operating at 9600 BPnS (bits per second) provides a data transfer rate of approximately 19200 BPS—about 16 times the rate of older 1200 BPS standards!

For we end users, how standards are created is of passing interest—we want solid ones that won't be soon obsolete. CCITT V.32 and MNP-5 will be around for a long, long time.

Derick Moore, Director of Engineering

See JDR's modem selection on the next page.

YOUR MOTHERBOARD CONNECTION!



MINI 25MHz 386 — $799

• NORTON SI 26.6 • LANDMARK AT SPEED 30.1

"THE FASTEST NON-CACHING MOTHERBOARD THAT WE TESTED."—BYTE MAGAZINE, APRIL 1990.

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- AMI BIOS • SIZE: 8.5" X 13"

MCT-M386-25 ..... $799.00

MCT-M386-M25 PROPRIETARY RAM CARD $99.95
1/2MB USING 36/72 256KX1 DRAMS OR 4/8MB USING 36/72 1MBX1 DRAMS

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- 1/2/4/8MB ON-BOARD RAM USING 80NS SIMMS (0KB INSTALLED)
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- 8 EXPANSION SLOTS (ONE 32-BIT, SIX 16-BIT, ONE 8-BIT)
- AMI BIOS ASSURES IBM COMPATIBILITY
- 8/33MHz KEYBOARD ADJUSTABLE SPEEDS

MCT-386MBC-33 ..... $1495.00

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- 25MHz 80386 • REQUIRES 1 OF THE RAM CARDS BELOW
- SHADOW RAM FOR ROM BIOS
- MEMORY CACHING FOR SUPERIOR PERFORMANCE
- MEMORY INTERLEAVING FOR NEAR 0 WAIT STATE OPERATION (8 BANKS OF MEMORY REQUIRED)
- SOCKETED FOR 80387 OR WEITEK 3167 COPROCESSORS

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MCT-C386-M16 ..... $99.95

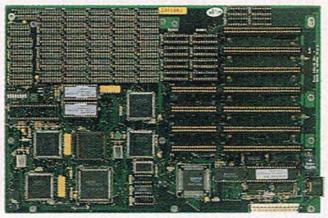
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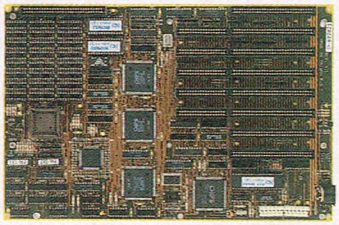


12.5MHz 286 — $199.95

• NORTON SI 14.3 • LANDMARK AT SPEED 16.5

- STANDARD 8088 LAYOUT
- 286-COMPATIBLE • 6/12.5MHz KEYBOARD SELECT SPEEDS
- EXPANDABLE TO 4MB ON BOARD; 512K/1MB USING 18/36 256KX1 DRAMS; 2/4MB USING 18/36 1MBX1 DRAMS (0KB INSTALLED)
- MEMORY SPEED: 120NS FOR 1 WAIT, 100NS FOR 0 WAIT

MCT-M286-12 ..... $199.95



16MHz MINI 386-SX — $399.95

• NORTON SI 15.3 • LANDMARK AT SPEED 20.8

- USES 16MHz INTEL 80386SX CPU
- EXPANDABLE TO 8MB ON BOARD
- 512K/1MB USING 18/36 256KX1 DRAMS OR 2/4 256K SIPS OR 4/8 256KX4 AND 2/4 256KX1 DRAMS; 2/4MB USING 18/36 1MBX1 DRAMS OR 2/4 1MB SIPS; 6/8MB USING 36 1MBX1 DRAMS AND 2/4 1MB SIPS AMI BIOS
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• NORTON SI 20.3 • LANDMARK AT SPEED 26.3

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16MHz 286 W/NEAT CHIPSET — $289.95

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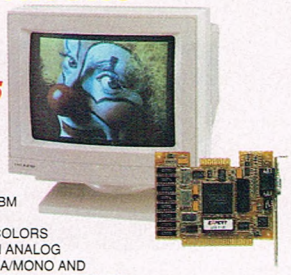
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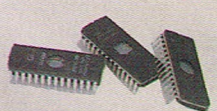
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2764-250	8192x8	250ns	12.5V	28	3.69
2764-200	8192x8	200ns	12.5V	28	4.25
27128	16384x8	250ns	12.5V	28	4.25
27128A-200	16384x8	200ns	12.5V	28	5.95
27256	32768x8	250ns	12.5V	28	4.95
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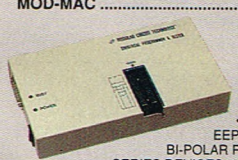
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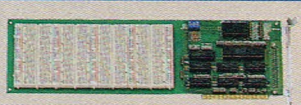
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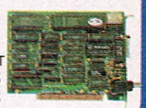
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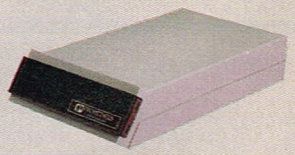
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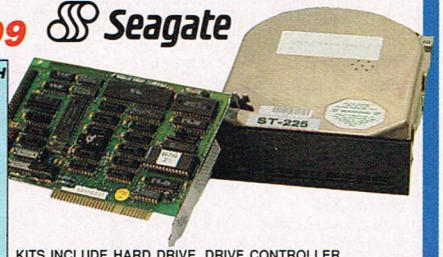
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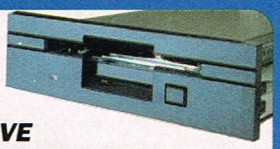
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CHAOS MANOR MAIL

Jerry Pournelle answers questions about his column and related computer topics

Expansion Solution

Dear Jerry,

Last November, I wrote to you to ask if you knew of any way that I could add extra slots to an AT in which the existing expansion slots were already full. You replied that you did not know of any available commercial equipment for this. I got similar replies from other sources, as well.

You might be interested to hear how I have solved this problem. An inquiry to Jameco brought the information that the company has an extender card/slot kit, catalog number PCL755C. It consists of a card that plugs into a 16-bit slot and is connected to a second card by three plug-in ribbon cables. The second card has one 16-bit and two 8-bit slots. By simply adding another edge connector, it can easily have a total of two 8-bit and two 16-bit slots. Power for the additional slots can come from the main computer (via the ribbon cables) or from an external source (+5 and +12 volts).

I bought this extender kit, along with an XT flip-top cabinet and an XT power supply. The second extender board (the one with the additional slots) mounts easily in the XT cabinet. I only had to drill six mounting holes and mount the extender board on brass standoffs that were provided with the cabinet, instead of using its own plastic mounting standoffs. The +5- and +12-V cables from the XT power supply had to be extended to reach the power connector on the extender board. The −5- and −12-V (low-current) supplies still come from the main computer. The +5- and +12-V supplies from the main computer to the extender are disconnected by removing two fuses on the extender board that plugs into the computer.

I removed one 8-bit card (which was in a 16-bit slot) from the main computer and replaced it with the first extender board. This card was then put into one of the 8-bit slots in the XT case. I used another slot for a scanner, and I now have two spare 16-bit slots. As soon as I can afford it, I intend to mount a backup tape drive and its controller in the XT cabinet.

The ribbon cables between the two cabinets probably would radiate RFI in excess of FCC requirements. Although this did not bother any electronic equipment in my house, and I am well away from any other houses, I provided some shielding. To do this, I fabricated a metal trough that bolts to both cabinets and fully encloses the cables. A crude solution would be to use grounded aluminum foil.

The extender card kit is rather expensive, especially considering that it is made in Taiwan. It costs $99.95 plus freight. The total cost was about $220, including freight, extra connectors, and so on. For this, however, I have been able to add a scanner. I will be able to add an internal tape backup (which is less expensive than an external one) and will still have a spare slot left.

L. D. Thomas
Georgetown, DE

Thanks for letting us know!—Jerry

Adding Up Bytes

Dear Jerry,

I am writing you to explain the discrepancies that you found with the reports of XTree and the Norton Commander (Computing at Chaos Manor, February).

What you got is not very odd. The total number of files is right: CHKDSK reports three hidden files, one of which is the Volume Label (if you do some peeking around with the Norton Utilities, you'll find it stored in your root directory like any file; it just has a special attribute bit set), and the IO.SYS and MSDOS.SYS system files. Of these three "files," XTree (correctly) counts just the last two. Add two to the 1662 "user files" that CHKDSK reports, and you have the 1664 that XTree reports.

Note that all the figures the Norton Commander gives you for total directory space are exact multiples of your cluster size (2048 bytes). That is all the space allocated to your files, including the slack area at the end of each file. On the other hand, when you select some files, the Norton Commander adds their "logical" length, without the slack. If you run File-Size in your directory, it will give you both figures. So, your small directory contains three files that use five clusters, even though part of that space (10,240 − 6128 bytes) is wasted.

The differences in total drive size can also be explained by considering that you could take 1 MB = 1,000,000 instead of the correct value: 2^{20} = 1,048,576 bytes.

Neither XTree nor the Norton Commander is wrong; they just do different computations.

Gino Lucrezi
L'Aquila, Italy

I confess that I get lazy sometimes in a case like this, since I know I can count on a reader to explain what's going on. Thanks!—Jerry

Locating Genius

Dear Jerry,

I just read your comments on Kun Yung Enterprise's Genius Genitizer (Computing at Chaos Manor, August).

I found a U.S. address for KYE International in a database called COMPLIB on CompuServe. That's where I find the names, addresses, and telephone numbers of most manufacturers. KYE International can be reached at 12675 Colony St., China, CA 91710, (800) 456-7593 or (714) 590-3940; fax: (714) 590-1231; BBS: (714) 590-3485.

Andre Mallette
St.-Leonard, Quebec, Canada

Thanks. Of course, we good BIX users don't use CompuServe, but. . . .

I did manage to make contact with the company eventually, and the people there say they'll put the U.S. address in their new stuff.—Jerry ■

Jerry Pournelle holds a doctorate in psychology and is a science fiction writer who also earns a comfortable living writing about computers present and future. He can be reached c/o BYTE, One Phoenix Mill Lane, Peterborough, NH 03458, or on BIX as "jerryp."

PRINT QUEUE

Hugh Kenner

Stomping the Nasties

A field guide through the jungle of computer invaders

Viruses—There Are No Such Things! That statement appeared in print some three years ago. But there are *so* such things, as the fracas at InterNet/ARPANET demonstrated late in 1988. That was when, coast to coast, 6200 machines got immobilized by what seems to have been a prank that outran control.

But what, *me* worry? I sit tight at my home machine. Well, no, you needn't worry, not at all, provided only (1) your machine has no modem link to the outer world; (2) you never share floppy disks with anyone; (3) you run no software save what you've written yourself. So runs the considered opinion of John McAfee, coauthor (with reporter Colin Haynes) of *Computer Viruses, Worms, Data Diddlers, Killer Programs, and Other Threats to Your System* (St. Martin's Press, 1989, $16.95).

McAfee is founding chairman of the Computer Virus Industry Association, which logged over 300,000 virus infections in 1989 alone. And how many went unreported? That's anyone's guess. Users are ready to blame malfunctions on, oh, operator error. It's when linked machines malfunction identically that suspicion begins to stir. And when suspicion stirs in Silicon Valley, it often prompts a call to John McAfee, who climbs into a motor home that is loaded with virus-catching equipment and steers toward the new client's parking lot.

Those of us who lack occasion to call on McAfee can profitably read his book. It does the great service of helping us understand what there is to worry about. And viruses do offer plenty of reasons to worry.

Like "hacker," "virus" is a term misused to the point of utter confusion. First, we are not talking about the antics of crackers, who infiltrate systems to filch credit-card numbers or just leave word that they called. We are talking about a piece of code. Not just such a piece of code as is meant, say, to install an illicit account in a certain bank's system and gently transfer funds to it. That's a worm. And not just something meant to go berserk on a preset date. That's a logic bomb. (When a Maryland library withheld payment for a bug-riddled system, it discovered that the supplier had installed a logic bomb: "Pay up, or your data vanishes!" Luckily, it was located before it went active.) And not just malign software disguised as something interesting. That's a Trojan horse.

No, a bona fide virus may resemble any of the above, but it has one further and deadly capability. It replicates. That means a single copy can spawn many thousands on many thousand machines. And how does that happen?

Well, somehow or other you've acquired a floppy disk with a virus embedded in one program (its host). Its first act is to separate from its host and make copies of itself that go hunting through your directories for other hosts they can live in. Any new floppy disk you install will be likewise searched; eventually, the virus will be lodged in a program you'll in all innocence pass on to a friend. . . and so on.



Which so far amounts to very little, save that increasingly numerous programs grow bigger by a few bytes. That was all the famous InterNet virus was meant to do: just spread itself about, to the glee of its perpetrator. Unfortunately, it contained a mild coding error. It should have kept clear of programs it had already infected. It didn't; soon, 6200 interlinked machines were busy at nothing save jamming one another till CPUs saturated and system after system died. (Estimated total damage in lost access time and wasted work: $98 million.)

McAfee offers fascinating detail on how a virus rolls up its sleeves. Thus, a few, like the Pakistani Brain—toward which virus-catchers genuflect respectfully—concentrate on the boot sector, the handful of bytes that load the

ILLUSTRATION: ANNIE LUNSFORD © 1990

operating system. They move that to a sector they flag "unusable," and then replace it with a customized boot sector that will be in control the next time the machine is turned on.

From now on, Darth Vader is running your machine, on the lookout for opportunities. He can intercept any attempt to modify the boot sector. And if you try to *check* the boot sector, why, he shows you the clean original he first stashed away! And *every* disk placed in the computer becomes infected instantly. "In some corporations, boot sector viruses have spread to a thousand computers in less than a week," says McAfee. The Pakistani Brain itself "rampaged through the newsroom and bureaus of the *Providence Journal*," apparently after one employee put an infected disk in a home computer.

And so what? Well, the Pakistani Brain is by no means as innocent as the InterNet virus was intended to be. It asks for ransom. Nonpayers find files trashed and systems crashing. No one knows how many copies lie dormant here and there. It was spread from Pakistan on disks with pirated copies of WordStar and Lotus 1-2-3, sold at a fraction of the U.S. makers' prices. The author's motive? Apparently, irritation when programs he himself had written were pirated.

So just avoid bootleg copies? Alas, you cannot be sure. Programs routinely go out for beta testing—massive usage, to find bugs—and who knows what beta testers may have done to the disks they send back? Or not know they have done? An innocent beta tester returned to a Seattle firm a disk he'd worked with on a Macintosh he didn't know was infected. Soon, thousands of distributed copies were carrying disease. (The firm—Aldus—acted responsibly, at heavy cost.) So you'll understand the panic of the man whose newsletter shouted *Viruses—There Are No Such Things*. His business was selling public domain software on disks. Public domain? That's distributed via multiple acts of copying. Who knows who's been meddling with it en route?

And who are these meddlers? In an interview I've read elsewhere, McAfee said he had no idea, except that some of them were pretty smart programmers. The more lurid ideas in the book he has cosigned we may perhaps ascribe to his collaborator, who likes phrases like "operating on the dark side." Chapter 6, "A Walk on the Dark Side of a Subculture," presents isolates who shun "conventional human contact," silicon being so much more dependable. One of them, who'd broken into Digital Equipment's system, shed tears on being accused of "harming a computer." Couple a sensibility like that with "a real or imagined grudge against big business, the government, or the computer community establishment as a whole," and you have (it says here) such a psyche as shoots at random into crowds.

OK, let's buy that to go on with. My problem with all such scenarios is that, accurate or not, they set adrenaline pointlessly flowing. Better to gaze calmly at such gems as the list, on pages 89–91, of just under 400 common passwords. That list was embedded in the InterNet virus, which it served as a skeleton key: "Over 90% of all large systems" have "at least one user" whose password it exhibits. Be sure that key fits no lock of yours. (Some samples: Dog, Batman, Rolex, Carmen, Wisconsin. . . .)

Or ponder the fact that you're reading this review (and I hope will read the book). But you're a computer-literate reader of BYTE. And administrators and law enforcers are apt to be so far from computerdom they either can't begin to comprehend what's been done wrong or else just panic blindly. When PCs at Lehigh University were infected in 1987, Lehigh fired the programmer who'd identified the virus and written an antidote. (If he knew so much, maybe he planted it in the first place?)

There are three types of antiviral products, all useful, none totally safe.

Or read the section on antiviral products and how they work. There are three main types, all useful, none totally safe. One type tries to keep viruses out, and it can be confused by things programs do normally; thus, it can emit so many false alarms you stop paying attention. Also, it's vulnerable to the boot sector strategy, which has taken effect *before* the antiviral program—or anything else—is loaded.

A second type tries to find and defuse viruses as they arrive; best, by keeping a "snapshot" of the system status when it's installed and thereafter watching for ominous variations. A third type looks for and cleans up viruses already present; its weakness is that it needs constant updating to insert the fingerprints as new strains get identified.

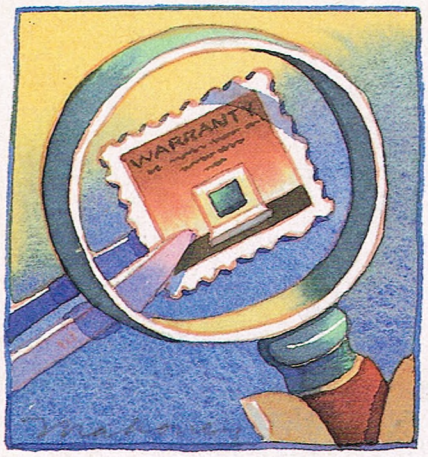
For a 50-page chapter on 73 known PC viruses—what they do, how to find them, how to zap them—try Richard Levin's *Computer Virus Handbook* (McGraw-Hill, 1990, $24.95). This big book is meant for serious computer users; the McAfee-Haynes volume trolls for curious bystanders as well.

If you don't feel like paying $16.95 for McAfee-Haynes, you can get it free with a program called Virucide (from Parsons Technology, 375 Collins Rd. NE, Cedar Rapids, IA 52402, (319) 395-9626). Although Virucide is not mentioned in the book, Parsons assures us that McAfee had a hand in it. From the fact that an updating policy is announced, I'll guess that it's mainly type 3. (The manual keeps a *very* low profile and digs itself the usual foxhole: No Warranty of Any Kind.)

Well, Virucide installs easily, runs fast, and tells me that my "preowned" 386 system shows no trace of a virus in any of some 20 megabytes of preowned software. That's a comfort, even though I'm left unsure how much reassurance it may really offer. Next? Well, I'll, yes, run Virucide periodically. And reflect that I can never hope to be in what medical virologists call a sterile environment. ■

Hugh Kenner is a professor of English at Johns Hopkins University. He writes for publications ranging from the New York Times *to* Art & Antiques. *His recent books include* Mazes *and* Historical Fictions. *He can be contacted on BIX as "hkenner."*

Your questions and comments are welcome. Write to: Editor, BYTE, One Phoenix Mill Lane, Peterborough, NH 03458.



PROMISES, PROMISES

What's in a warranty? Most of the time, not much

When computers first became commercially available, they were bundled with software and sometimes maintenance agreements. Were those sales considered "sales of goods" (and therefore under the purview of the Uniform Commercial Code), or were they "sales of services," controlled by contracts and common law? Was software an intangible or a product? Was a maintenance agreement part of a sales transaction or a service arrangement?

This is just the kind of meaty debate that lawyers who know nothing about technology love. They held tax-deductible meetings in exotic locations, filed lawsuits, and issued proposals. After the expenditure of millions of dollars, it was decided that sometimes a system is a sale of goods, and sometimes it isn't; it all depends.

With those issues clarified, let's move on to how goods are sold. When a salesperson makes promises of vectors per second or immediate rendering, are his or her words legally binding? In most instances, the law will find that whatever a salesperson says is *precatory*. That word would be better spelled *pred*atory, but precatory is an aspect of caveat emptor—let the buyer beware. A reasonable person should know that the Brooklyn Bridge is not for sale and that if it is, it needs a lot of repair work and a coat of paint.

On the other hand, what a salesperson says is sometimes considered a warranty, even though the first thing you see when you unbox a new system is a piece of paper saying you have no warranties except for a limited 90-day or one-year warranty. That limited warranty typically says that if you don't follow certain conditions, such as returning the equipment in its original packaging, the warranty is off. Of course, computers and peripherals are packaged in boxes 20 times their size, with foam rubber inserts, molded plastic sidings, and millions of foam peanuts. Saving the packaging eventually means renting space in a warehouse.

The limited warranty then says that the company will replace the failed component with a new one or a used one, at its discretion. This is known as the *law of refurbishment*. One new twist to the law of refurbishment is that used equipment is sometimes refurbished and resold as new. Recycling used equipment has even spawned its own specialists: repackagers who clean equipment, spray it with that smells-like-new odor, rewrap cables in plastic bags, re-shrink-wrap manuals, iron out wrinkles in boxes, and put in blank registration forms. Now you know why they make you return equipment in its original wrappings.

Warranties are covered primarily by the Uniform Commercial Code. The word "uniform" is used to throw off nonlawyers so that they're forced to hire lawyers who understand that uniform means one thing to the public and another to lawyers. This code is not uniform, having been adopted by some of our states with variations. In situations such as this, lawyers use the phrase "the general rule is." The general rule is that just about every warranty (and remedy) can be disclaimed by a seller if the disclaimer is printed in VERY BIG TYPE.

But suppose a salesperson tells you that a system is capable of performing in a certain manner, and you purchase it relying on that statement. You later find that the system does everything from barking like a seal to waking you up in the morning, but it cannot do that one thing that you bought it for. Then you might have a case for a breach of warranty of fitness for a particular purpose. Of course, getting a judge to pronounce your victory will probably cost you more than the system did.

Then there's the law of disappearing days. Suppose you have a 90-day warranty and you didn't purchase a service plan. The machine breaks down on the tenth day. It takes you four days to retrieve all the foam peanuts, three days to repack the equipment, and 16 days to obtain your authorized return number. Sending the machine back using a ground service will take four to five business days but will cost only a few dollars, or you can use an express service that will deliver the machine in a day or two for what it cost you to purchase the equipment. Inevitably, you'll get the machine back one day after the warranty has expired.

A decent manufacturer (or dealer, or mail-order house) will extend the warranty period to take into account when the machine failed and when it was returned repaired. Some states require the extension. But guess what? In most cases, the burden of an extension is on the purchaser. In other words, you are providing yourself with your own warranties.

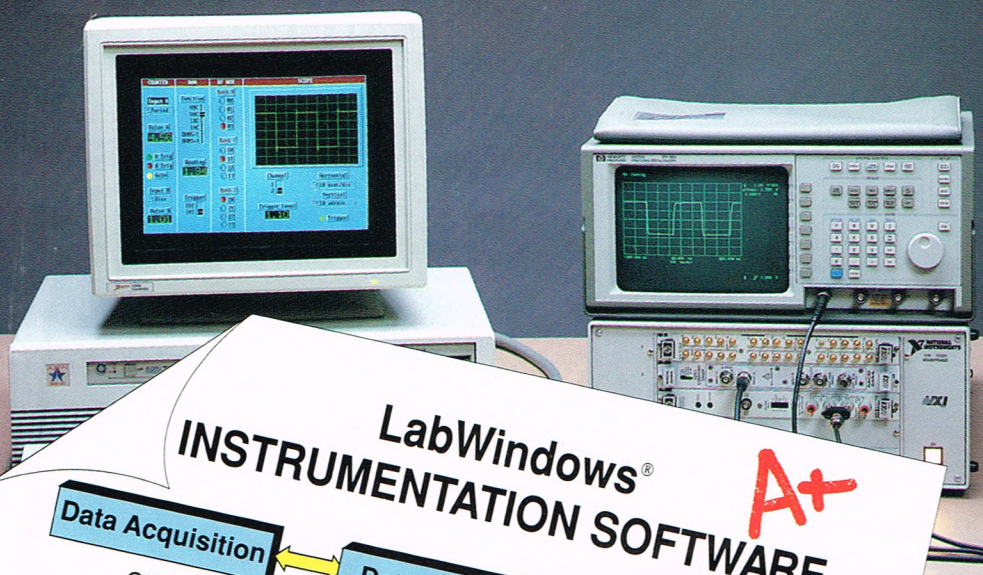
That's what democracy is all about: If those manufacturers won't give you a warranty, you are free to pay for one. ■

Stop Bit is an open forum for informed opinion on topics related to personal computing. The opinions expressed are those of the author and not necessarily those of BYTE or its staff. Your contributions and comments are welcome. Write to: Editor, BYTE, One Phoenix Mill Lane, Peterborough, NH 03458.

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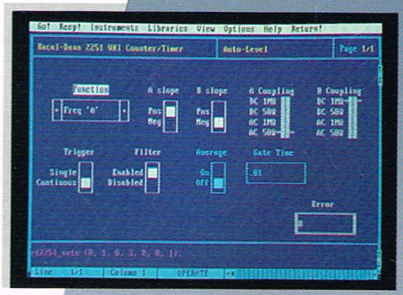
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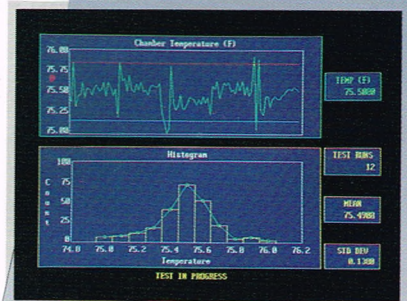
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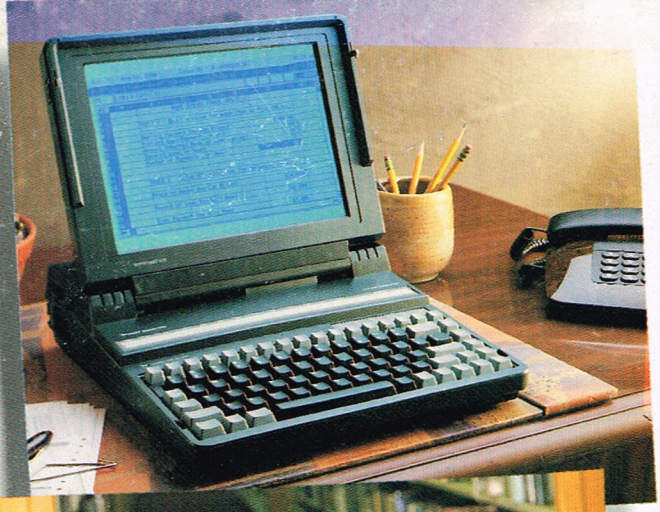
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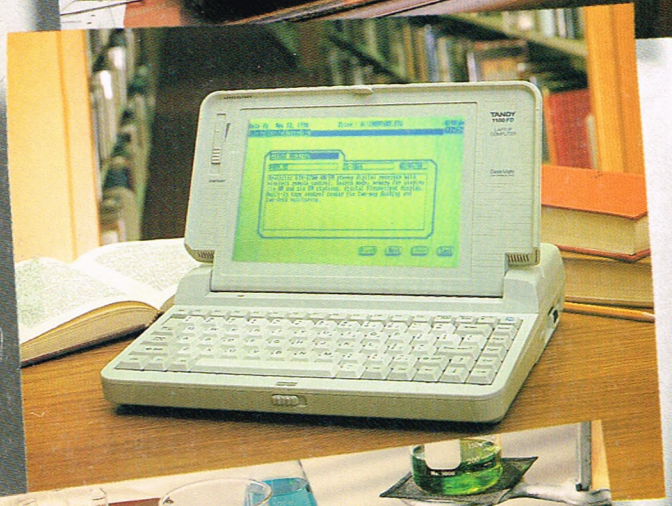
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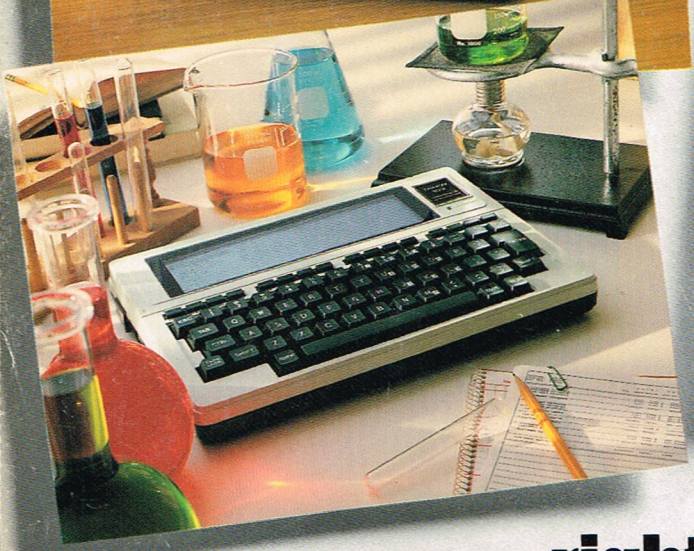
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